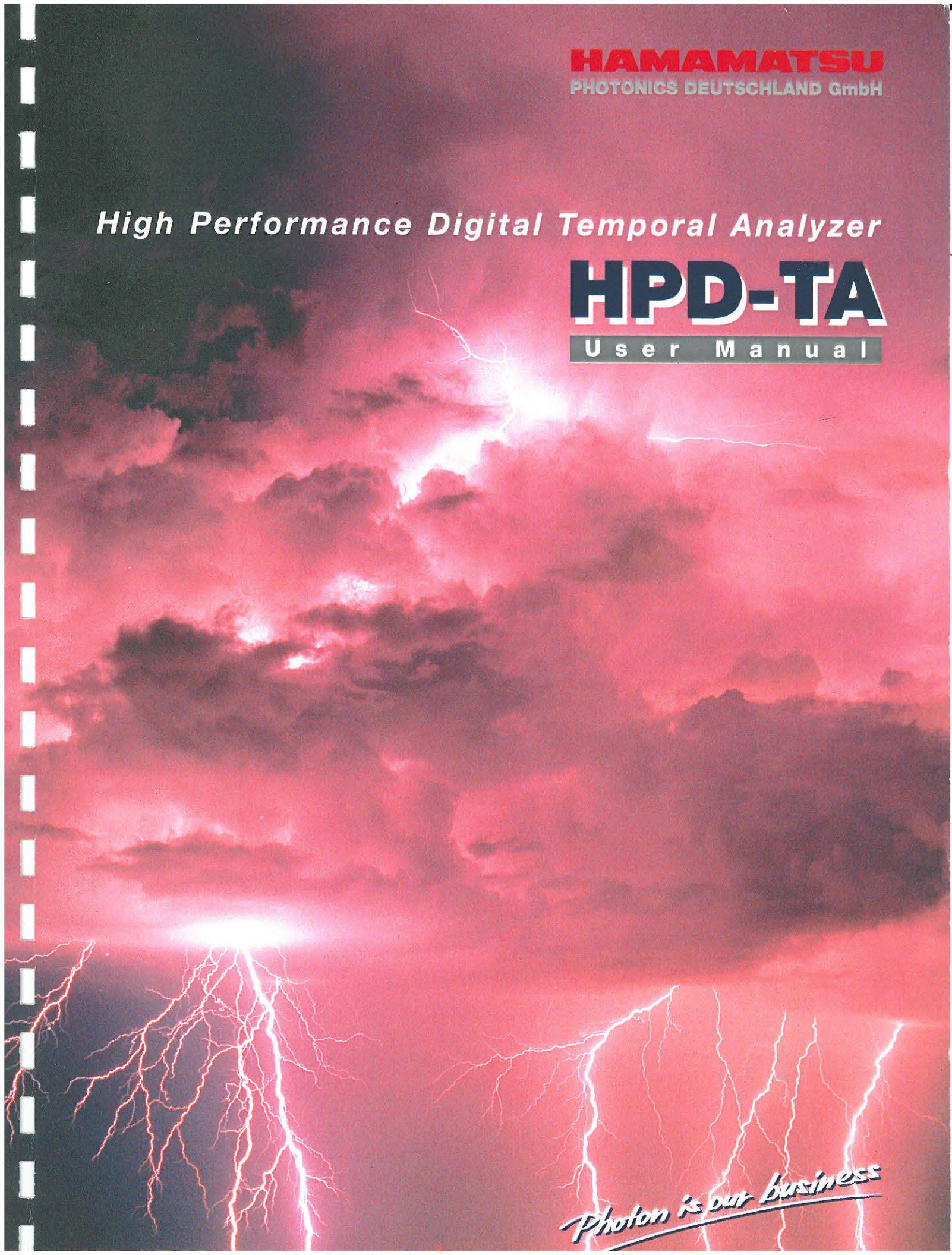
HAMAMATSU
PHOTONICS DEUTSCHLAND GmbH

High Performance Digital Temporal Analyzer

HPD-TA

User Manual



High Performance Digital Temporal Analyzer, Version 7.0

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User Manual

HAMAMATSU

Photon is our business

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Content

Introduction

General

The **HPD Temporal Analyzer (TA)** system is a high-performance digital image processing system designed to read-out images from the phosphor screen of Hamamatsu streak and framing cameras. It enables precise acquisition and quantitative analysis of two-dimensional streak and framing data, including a full range of data correction and calibration functions.

If used in combination with a new-generation streak camera it also provides remote control of all streak camera functions via GPIB interface.

The standard version of the system employs a state-of-the-art high resolution cooled CCD device (the C4742-95, C4742-98 or the C4880 Cooled CCD Camera) as an image sensor. With this camera it is possible to use the system also for other purposes, for example for spectrograph readout. Provided that the special features and the performance of a cooled CCD camera are not required the user may also choose another special video CCD.

The camera is connected to an IBM-compatible PC via the frame grabber board IC-PCI (Image Capture for the PCI bus).The board performs tasks like digital image acquisition, pseudo-colour generation or image accumulation.

You may use this manual for two reasons:

- To get started with the digital image processing system
- To get detailed information about complex operation methods and procedures. Since **HPD-TA** is a "look and feel" program, you may not need this manual for your daily work. However there are several functions which may not be understood easily by just using the program. We have put priority to explain such items in this manual.

You should read several parts of this manual before you start.

We recommend to read the chapter "Set-up and Installation" on page 13 first. Then you should read the chapters "Starting the program" on page 20, "Basic operations" on page 36 and "Setup menu" on page 56.

The chapter "Getting started" will show you step by step how to acquire your first images, the chapter "Starting the Program" tells you in more detail, how to start-up the program and gives you an overview about the main commands. In the chapter "Basic Operations" you will find important basic information about the program", in the chapter "Setup menu" a description about commands for system set-up is given. You should be familiar to these commands before you use the system extensively and make the set-up according to your system configuration.

If your system was installed by Hamamatsu already, you may skip the chapter "Set-up and Installation".

Later on you may use the manual to understand and use special functions.

We assume that you are already familiar to Microsoft Windows/Windows NT and its standard operations. If you use Windows/Windows NT for the first time, please study its functions first.

Before you read this manual you should check your actual hardware system configuration. Since several **HPD-TA** functions are different depending on the actual streak camera or readout camera, it is important to know, which system is used. **Note: C4742-95 is the Hamamatsu type number for ORCA , C4742-95ER is the type number for ORCA ER and C4742-98 is the Hamamatsu type number for ORCA II. In this manual only type numbers are used for camera identification.**

Update Information

*If you update your **HPD-TA** software from an older version to the actual version, you may want to know, which functions have been added compared to your old version. Following chapter describes these changes. If you use **HPD-TA** for the first time, you do not need to read this information.*

What is New in HPD-TA 2.0?

HPD-TA 2.0 is a new main version and has the following new features and improvements:

- A new and powerful PCI-based state of the art frame grabber is supported. It is the IC-PCI from Imaging Technology (ITI).
- Support of 14 and 16 bit data acquisition.
- Image display on the VGA monitor.
- Display of more than one image at a time.
- Support of a mode where images can be viewed analysed and saved without frame grabber.
- Most functions perform considerably faster than with older versions.
- Fully compatible to image and profile files of older program versions.
- A new hardware lock is used. AFG board with the protection GAL still works.

What is New in HPD-TA 2.1 and Higher?

HPD-TA 2.1 is a new sub-version and contains the following new features and improvements:

- A sequence mode for the C4880 for fast acquisition of sequences is available. This works as fast as the camera can output images and is only limited by the size of RAM in your computer.
- An acquisition module (the AM-VS) to acquire analog video images for the IC-PCI is supported. With a special small hardware also on-chip integration for the Hamamatsu C3077 and C5405 cameras is supported.
- Support of the C4880-81/82 camera models.

-
- A fitting module for fluorescence lifetime measurements is available as an option.

In addition to these features the sub-version **HPD-TA** 2.1.2 includes the following new features and improvements:

- Improved support of the C4880-81/82 cameras.
- Support of the C4742-95 camera
- Support of the C4880-96/97 cameras
- Image size can be 1280 x 1024 pixels now (Acquisition of this size is only possible with the 4M version of the IC-PCI)
- Now scaling tables can have a length of 1280 floating point values (old type scaling files can still be used).
- The sequence mode also works if the vertical blank (VB) is very short. Older versions of the program have required a VB of at least several milliseconds duration.
- Several bug fixes of the previous version

In addition to these features the sub-version **HPD-TA** 2.1.3 includes the following new features and improvements:

- A jitter correction function which can work with images on hard disk, images in sequence RAM and profiles on hard disk is available now.
- A special mode allows to purchase only the fitting licence. In this mode the user can save and load data, do fitting but cannot do image acquisition.
- Support of the C6878 delay unit and the M5679 dual time base extender (option for the C5680). Currently supported devices are: C1587, C2830, C5680, C3681, C4334, C4187, Chromex 250IS, Chromex 500IS, DG535, C1097-01, C4792-01, C6878.
- In the cycle mode images can be saved in IMG, DataToTiff and DisplayToTiff Format.
- A new improved photon counting algorithm for the video acquisition. Photon counting can now be done in real time (provided the computer is fast enough). There are three methods for photon counting now: centre of gravity, peak detection and slice mode.
- If no license is available (no hardware lock or GAL) the system starts in demo mode. Then the user has the possibility to select between acquisition and processing mode. In acquisition mode the user can acquire images (including sequence function if available for the camera/frame grabber) but cannot save data (images or profiles). In processing mode the user can save and load data but cannot do acquisitions.
- The shutter camera C5987 (C4880-92) and the sub-nanosecond shutter camera C6918-05 (C4880-93) is now supported

In addition to these features the sub-version **HPD-TA** 2.1.4 contains the following new features and improvements:

- Framing cameras are now supported. A framing camera setup function allows to split up one acquired image into several frames.
- The 4742-95 camera can now be operated in Live, Acquire, Analog Integration and Photon Counting mode.

- The performance of Photon Counting and Analog Integration have been enhanced. For analog video cameras these modes can be performed in real-time.
- TIFF files have now scaling information. It is possible to save sequences in TIFF format. The FITS format is supported.
- New functions for ROI handling have been implemented. It is now possible to move and resize ROIs.
- It is now possible to save just data within a ROI in sequence mode.

What is New in HPD-TA 2.2?

HPD-TA 2.2 is a new sub-version and contains the following new features and improvements:

- A new sensitivity correction function for spectroscopic applications has been implemented.
- The Realtime Profile function is replaced by a more versatile function called QuickProfile.
- The sequence function is now also available for standard analog video cameras
- Images can be saved in ASCII format
- Sequence function has been improved. Now cyclic acquisition and replay is possible. It is possible to display images during sequence acquisition.

What is New in HPD-TA 3.0?

HPD-TA 3.0 is a new main version and has the following new features and improvements:

- eThe program is now true 32 bit code and runs under Windows NT as well as Windows 95
- It is now a MDI (Multiple document interface) application
- The image save and image load functions have been completely revised to allow a more user friendly operation
- The analog integration function has been optimised to work accurately even with critical short integration times
- The look and feel of all image acquisition modes has been improved (including tool-tips for online information)
- A new option called "After-trigger integration for analog video camera configurations has been introduced

Following features are **not any more available** since this version:

- The frame grabber AFG is not supported any more
- The camera C4742-01 is not supported any more
- The program does not run under Windows 3.1 any more

- Camera On-chip integration with standard analog video cameras is not supported any more

What is New in HPD-TA 3.02?

HPD-TA 3.02 is a new subversion and has the following new features and improvements:

- and Cycle mode have been revised and unified in order to get a more versatile functionality. Processing speed has been improved.
- A new photon counting function for time resolved 2-D photon counting called Dynamic Photon Counting has been implemented.
- A emergency button has been introduced in order to close shutters and switch the MCP gain of a streak camera off immediately
- A function for time resolved absorption measurement is available as an option

What is New in HPD-TA 3.1?

HPD-TA 3.1 is a new subversion and has the following new features and improvements:

- A real-time background image subtraction function in Live mode has been added.
- Image display speed in Live mode has been improved.
- Non-linear contrast enhancement functions have been added.

Support of GPIB board KPCI488 has been added.

What is New in HPD-TA 6.0?

HPD-TA 6.0 is a new main version and has the following new features and improvements:

- The code is rearranged and grouped into objects. This has two consequences:
  A) Testing, bug-fixing and maintenance is easier.
  B) The program can be remotely controlled by another application.
- Support for C4880-8X is removed.
- There is a new menu command "Save ROI As" which saves only the ROI. The command Save As always saves the full image without prompting the user.
- The options are grouped more logically.
- A new error handler is installed which gives more precise information about the calling list and the latest executed commands/events before the occurrence of the error.
- The scaling for all time ranges can be loaded from a file.

- New timeout behaviour in many cases, especially in the case of triggered acquisition.
- Dual time base extender scaling has been improved. (An entry for every combination of main plugin and dual time base extender.)
- The software is no longer an MDI application

What is New in HPD-TA 6.1?

HPD-TA 6.1 is a new sub-version and has the following new features and improvements:

- Cooled CCD cameras with up to 16 bit A/D converter are supported. .
- A 32-bit file format is used. Previous versions can not read this file format.
- New frame grabber are supported: PCDIG for digital cameras and PCVision for analog cameras.
- New cameras are supported: ORCA ER and ORCA II series.

What is New in HPD-TA 6.2?

HPD-TA 6.2 is a new sub-version and has the following new features and improvements:

- Improved streak trigger methods have been implemented. .
- A second delay unit is supported now.
- C4880-8x type cameras are supported now.
- Auto delay handling is improved.

What is New in HPD-TA 6.3?

HPD-TA 6.3 is a new sub-version and has the following new features and improvements:

- Cameras with FireWire (IEEE1394) interface are supported using the Hamamatsu DCAM driver concept.
- Defect sensor pixel correction has been implemented.

What is New in HPD-TA 6.4?

HPD-TA 6.4 is a new sub-version and includes the following new features and improvements:

- The frame grabber types National Instruments PCI1422 and PCI1424 are supported
- A modified setup procedure has been introduced

What is New in HPD-TA 7.0?

HPD-TA 7.0 is a new version and includes the following new features and improvements:

- The acquisition of image sequences has been improved
- The new camera model C8800 is now supported

Set-up and Installation

Overview

*This chapter describes the hardware configuration, set-up and software installation of the **HPD-TA** system. If your system was already pre-installed by Hamamatsu you do not need to read his chapter.*

Note: Please install the software at first. Install the hardware in a second step.

Hardware Set-up and Configuration

The **HPD-TA** requires the following system components:

- Cameras with RS 422 or RS 644 interface:
  Frame grabber: **IC-PCI+AM-DIG,** or **PCDig,** or **PCI 1422** or **PCI 1424**
- Cameras with CameraLink interface:
  Frame grabber: **PcCamLink or PCI1428**
- Cameras with IEEE1394 interface:
  IEEE1394 adapter
- Analog cameras
  Frame grabber: **IC-PCI+AM-VS** or **PC-Vision**
- Computer environment:
  An industry standard PC (at least with Pentium processor) with at least 32 MB RAM (>64 MB recommended), a VGA board (PCI recommended), one free serial port (not required for cameras with IEEE1394 interface), one PCI slot, Windows'98, Windows ME, Windows NT, Windows XP or Windows 2000 is required. Additional PCI slots are required for GBIB and Counter/Trigger boards depending on the system configuration.
- **HPD-TA** software
- Camera:
  A Hamamatsu digital camera C4742-95, -98 (black and white version), C4880, C8800 or a camera with standard analog video signal (e.g. Hamamatsu C3077).
- Accessories (if C4880 C4742-98 is used):
  Depending on the camera type, a water cooler and vacuum pump may be necessary.
- A Hamamatsu streak camera

- The Trigger/Status Board (Data Translations DT2819 or counter board CTR05) and the Trigger Adapter Type A, B or C (optional)
- The Keithley PC488 GPIB board or the National Instruments GPIB board (optional)
- A spectrograph (optional)
- One or two delay generators (optional)

Software Installation

HPD-TA software is delivered on a CD.

Note: You should install the frame grabber board (or IEEE1394 adapter) into your computer **after** the software installation.

Start Windows'98SE, Windows ME, WindowsNT 4.0 SP6 ,Windows 2000 or Windows XP.

Note: Cameras with IEEE1394 interface are not supported under Windows NT.

Insert the CD into you CD drive. The installation program will normally be started automatically by a "autostart" routine.

If it does not run automatically, you have to select **"Run"** from the **"Start"** menu and type **D:\SetupTA.exe,** then click **"OK"** (assuming that your CD drive has the name D).

The set-up program will start displaying the setup launcher menu .

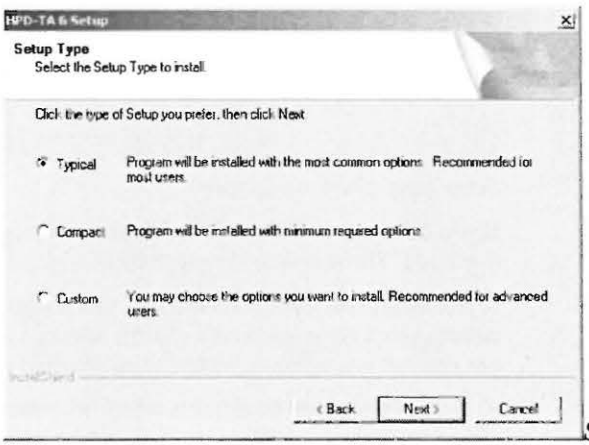
Follow the instructions displayed on the screen.

- Make sure that elder versions of the program are uninstalled before the new version is installed.
- Please collect information about the camera type and interface type (grabber, IEEE1394 etc.) before you start the installation. **Press Help on se-**

lecting cameras... to get some help about camera and interface selections.

Start with the software installation (Press "**Install the HPD-TA** ")

During installation you will be asked if you want to do a typical, compact or custom installation.



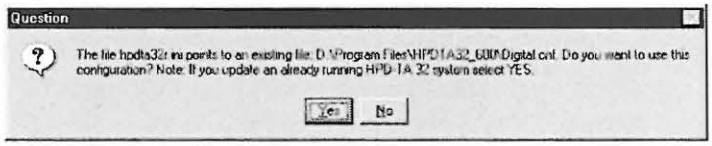
Setup type selection dialogue

We recommend to select "typical" installation. All necessary program components will be installed.

If you choose "compact", only the program components necessary to run the core program will be installed. Choose this option only if you want to use the program just for image analysis, not for image acquisition.

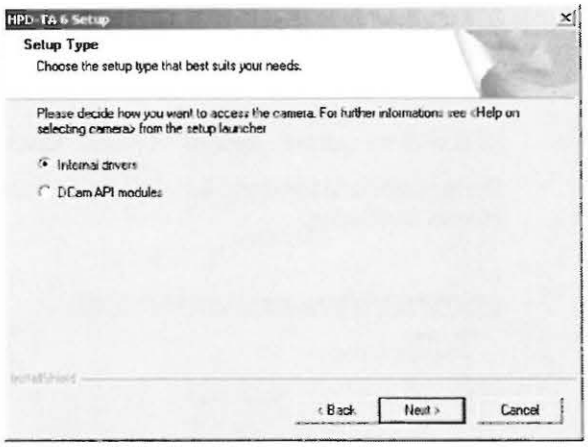
If you choose "custom" a dialogue box will be opened where you can choose the program components which you want to install individually. Choose this only if you are familiar with the program structure. The system may not work properly if you do not install the proper components.

If you have installed a previous version of the software a warning message will appear where you are asked if you want to overwrite the existing configuration file or not. Unless you have changed your hardware configuration you should use the existing file.



Depending on the camera model and camera interface type you have to decide which **setup type** you want to use.
Select **DCamAPI modules** for configurations supported by a Hamamatsu DCAM driver (e.g. cameras connected by IEEE 1394 interface).
Select **Internal drivers** for cameras not supported by DCAM.

Please ask your camera supplier if you are not sure which setup type you should use.

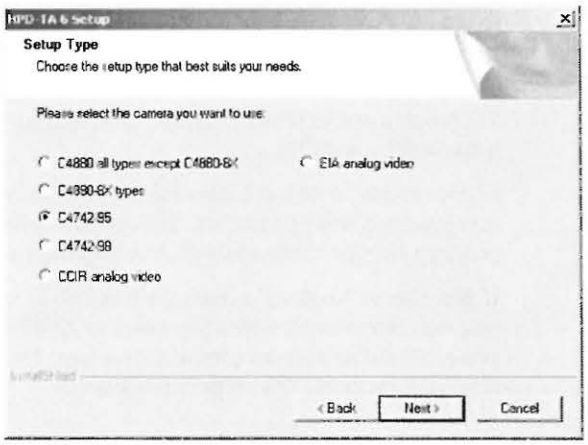


Setup type selection dialogue

If you have chosen **DCamAPI drivers** setup type, a warning message will be displayed. Please follow the recommended procedure for driver installation.

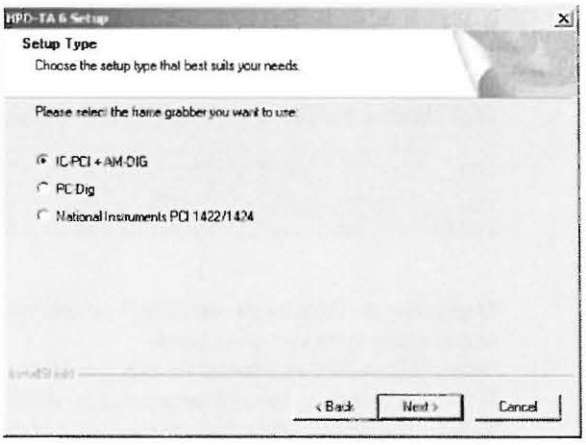
If you have chosen the **Internal drivers** setup type you will be asked which camera you want to use in the camera selection dialogue and which frame grabber you use in the frame grabber selection dialogue.

At first, please select the camera which you want to use.

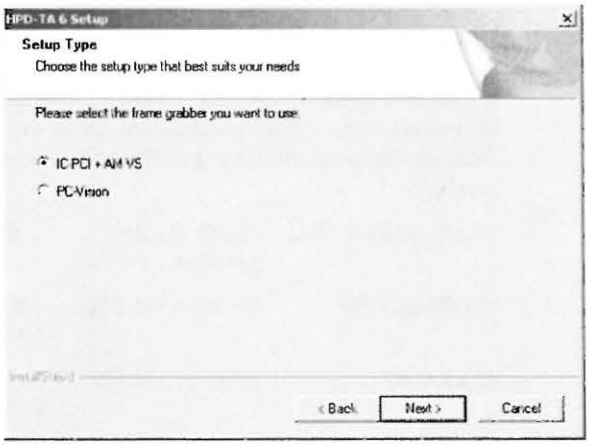


Camera selection dialogue

Please select the frame grabber which you intend to use in the next dialogue.

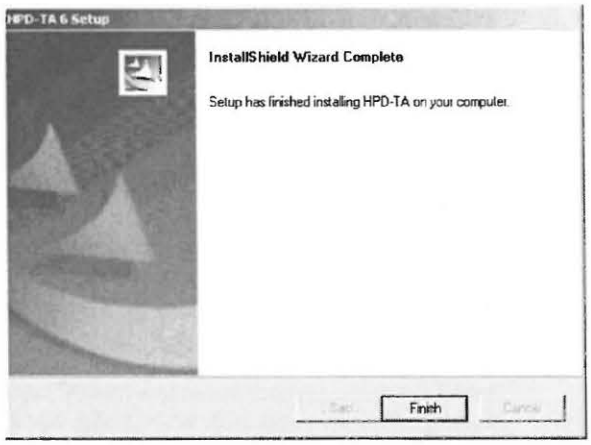


Frame grabber selection dialogue for digital cameras



Frame grabber selection dialogue for cameras with analog signal output

At the end of the installation you will be advised to install additional program components such as a hardware lock driver or a frame grabber driver and you will be asked if you want to reboot your computer. If you decide to do it later, you have to make sure that you do not start the program before you have re-started the computer.



Continue with the next installation step shown at the setup launcher.

Typically this is the installation of the hardware lock driver.

The next installation step is the installation of a hardware interface driver. You have to choose one out of the four alternative drivers (ITEX, IFC, NI-IMAQ or DCAM) shown in the setup launcher dialog. Please choose the proper driver for your actual installation.

The final installation step is the installation of the Acrobat Reader which is required to read the help file.

After completion of the installation you have to re-boot your system.

We recommend to read some parts of this manual **before** you start to work with **HPD-TA** for the first time. In order to acquire the first images, proceed with the chapters "Starting the program" on page 20.

The following chapter gives you additional information. However, you need to read it only in case you find some problems with your system.

Camera Configuration Files *.cnf

During installation the program will already load and activate the configuration file which fits for your configuration. However, if you want to change to another camera later, you should also change the configuration file (*.cnf). Please insert the correct name of the configuration file in the start-up window (see also "Starting the program" on page 20). Following configuration files are currently available:

Configuration file..	**...with frame grabber...**	**... for the cameras**
DIGITAL.CNF	IC-PCI+AM DIG	All digital cameras like C4742 (ORCA) series and C4880 series
CCIR.CNF	IC-PCI+AM VS	For analog video cameras with CCIR standard
EIA.CNF	IC-PCI+AM VS	For analog video cameras with EIA standard
PCVSCCIR.CNF	PCVision	For analog video cameras with CCIR standard
PCVS_EIA640.CNF	PCVision	For analog video cameras with EIA standard
PCDig.txt	PCDig	All digital cameras

The National Instruments frame grabber PCI 1422, Pci 142$ and PCI 1428 do not require such file.

Hardware Installation

Proceed with following steps to install the hardware of your **HPD-TA** system:

Step 1: Install the frame grabber or IEEE1394 interface board in your computer.

Install the frame grabber board in a free PCI slot of your computer. Following frame grabber are supported: IC-PCI with AM-DIG and AM-VS module, PCVision, PCDig, NI PCI 1422, NI PCI 1424, NI PCI 1428.

If you use a camera with IEEE1394 (FireWire) interface, an interface adapter is needed instead of a frame grabber board.

Step 2: Install the software protection.

In order to work with **HPD-TA** you have to install a hardware lock.

If this is not installed, **HPD-TA** works in demonstration mode only.

Connect the hardware lock (this is a 25 pin connector labelled with the name of the program or a USB stick type) to the parallel port (LPT1) resp. a USB port of your computer. The hardware lock is delivered with the **HPD-TA** program disk.

Step 3: Make the cable connections

- Connect all cables of your computer (AC cable, keyboard, mouse, monitor etc.)
- Connect all AC line cables of your other devices.
- Connect the camera to the input connector of the frame gabber board.

If you use a Hamamatsu digital camera:

- Connect the camera head to the camera controller.
- Connect the serial cable to a **serial interface** port (default: COM 1) of your computer. You can use any COM port, but you have to indicate this port during start-up (see also "Starting the program" on page 20). If you use a camera with CameraLink interface all control commands are sent via the CameraLink cable, so no additional serial interface cable is required.
- Connect the vacuum pump (only if a camera without permanent vacuum feature is used).
- Connect the water cooler (in case of a water cooled camera type).

Step 4: Install other hardware

Please refer also to „Appendix K: Typical hardware configurations" on page 205.

- If you use the Trigger/Status Board: Set it to the desired base address (default setting is 560 = 230Hex, see the DT2819 manual for details) and install it into your computer.
- Connect the Trigger/Status Adapter with the 50 pin flat cable.
- Connect the Status cable if a status port is available for the streak camera.
- Connect the Monitor Out and Reset cable in case a single-shot streak camera is used.
- Set-up the streak camera, the other devices and your optical set-up.
- Mount the C4742-95, C4742-98, C8800 or the C4880 camera on the streak camera mount table. If an analog video camera is used it is normally already installed in the streak camera
  Note: We recommend to connect an objective lens to your camera and look at ordinary images for to get the first images with the **HPD-TA** program. This allows you to get experience with the readout camera before you operate the complete streak system (see also "Starting the program" on page 20).
- If you use the Keithley GPIB board: Set it to the desired base address (default setting is 696 = 2B8Hex) and install it into your computer. Connect all GPIB devices to the board and remember their primary addresses (see also "Trigger setup" on page 76).

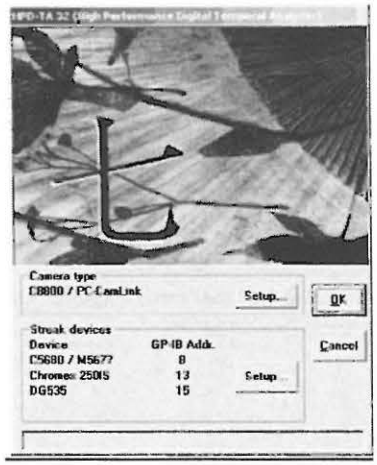
Starting the program

Start

The following chapters explain the system start-up procedure and give you an overview about the commands and functions of this program. You should read these chapters before you start to work with ***HPD-TA*** *.*

HPD-TA icon

After the installation of **HPD-TA** you will find the program icon in the program group "**HPD-TA 32**". Start the program by clicking at this icon or by another common method used under Windows. After **HPD-TA** has been started the initialisation dialogue box is displayed.



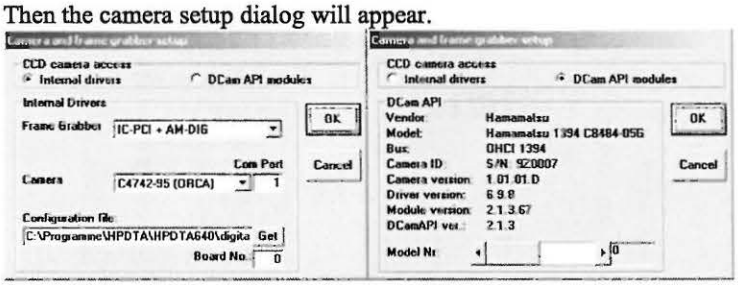
Initialisation dialogue box

Initialisation

You have to choose several basic settings which refer to your system configuration in the initialisation dialogue window.

Press Setup in the camera type section to prepare the settings for readout camera and frame grabber.

Then the camera setup dialog will appear.



Setup dialog when using internal camera drivers (left) and DCAM drivers (right)

CCD Camera Access

Select **Internal drivers** when a camera which is supported by HPD-TAs internal camera drivers shall be used. (Most cameras using a frame grabber use this method).

Select **DCam API modules** when a camera which is supported by a DCAM API module shall be used (e.g. cameras with IEEE1394 interface).

When **Internal drivers** is selected, you have to make following settings:

Frame Grabber

Please select the frame grabber which is installed in your system.

- If no frame grabber is installed you can select the type **None**.
- Select **IC-PCI+AM-DIG** if you have the IC-PCI board installed with a digital input module.
- Select **IC-PCI+AM-VS** if you have the IC-PCI board installed with an analog input module.
- Select **PCDig** if you have the PCDig board installed which has a digital input module.
- Select **PCI 1422/1424** if you have a National Instruments board installed which has a digital input module.
- Select **PCVision** if you have the PCVision board installed which has an analog input module.

If you have installed more than one frame grabber of the same type in your computer you have to select the number of the grabber which shall be used during the actual session in the **Board No.:** field. Please select 0 if only one grabber is installed.

Camera Type

Please select the camera type which is installed in your system.

Frame grabber	Cameras
No grabber	No camera
IC-PCI + AM-DIG	No camera C4880 standard C4742-95 (ORCA) C8484 C4880-8X

	C4742-98 (ORCA II)
IC-PCI + AM-VS	No camera Analog camera
PC-DIG	No camera C4880 standard C4742-95 (ORCA) C8484 C4880-8X C4742-98 (ORCA II)
PC-CamLink	No camera C8484 C8800
PC-Vision	No camera Analog camera
PCI1422/PCI1424	No camera C4880 standard C4742-95 (ORCA) C8484 C4880-8X C4742-98 (ORCA II)
PCI1428	No camera C8484 C8800

Frame-grabber/Cameras HPD-TA

Configuration File

The frame grabber will be initialised by use of special configuration files. Normally a pointer to the correct file is automatically established during software installation.

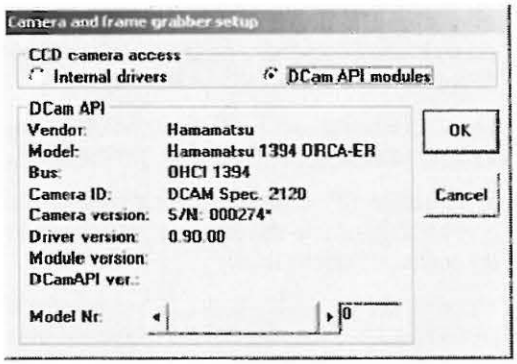
During installation of the program the user is already asked for the camera he wants to use and an entry in the initialisation file is already set specifying the configuration file and camera.

If you want to select another configuration file you should enter the correct file name for the configuration file in the text box **Configuration file.** (see also "Camera Configuration Files *.cnf" on page 18). Press **Get** in order to open a dialogue for the file selection.

Note: The program will save your settings automatically. When you start it the next time you will find that the previous settings are already set.

If all settings are finished you have to click **OK** in order to display the main program window and the LUT tool.

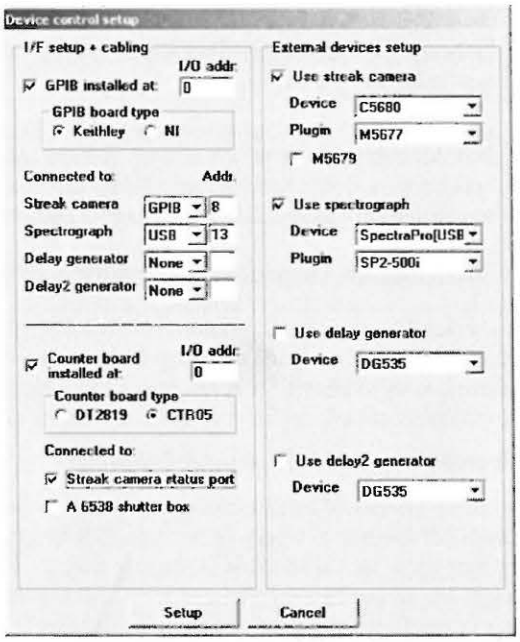
If a camera shall be used by employing the **DCAM API Modules**, no additional settings are required.



Setup dialog using DCam API

Streak devices set-up

Press Setup in the Streak device section to prepare the settings for the streak camera and accessories.



Device Control Setup dialog

The streak camera set-up tells the system about the type and configuration of the connected streak camera and other peripheral devices and how they are connected to the system.

Note: It is important that the device control setup is done correctly before you try to operate external devices. If you are unsure please consult Hamamatsu.

Note: Device control setup is rarely modified and it is automatically saved/restored between HPD-TA sessions.

HPD-TA allows to connect any Hamamatsu streak camera and other peripheral devices such as spectrographs and delay generators (see also Appendix H). Some Hamamatsu streak cameras have a 16 bit digital port called status connector which can be read to get information about the internal streak camera status, like time range etc. Some Hamamatsu streak cameras can be controlled by a GPIB or USB interface and the status can be inquired via the same interface. Single shot streak cameras have "trigger in", "monitor out" and "reset" connectors (normally BNC connectors) to perform a sophisticated trigger handshake which is fully supported by the **HPD-TA**. Other peripheral devices such as spectrographs and delay generators can also be controlled by GPIB or USB. To perform the device interfacing a Data Translation DT2819, a counter board CTR05 and/or a Keithley PC488 (alternatively a National Instruments) GPIB I/F board are used. The Data Translation board or counter board can perform the

trigger handshake and read the status from the status connector of the streak camera. The GPIB board performs the communication with GPIB controllable devices (streak camera and/or other devices).

The device control set-up dialogue box has two main sections. A section **I/F setup + cabling** and **External devices setup**.

In the section **I/F setup + cabling** settings about the interface boards which may be plugged into the computer, I/O base addresses and about devices which are connected can be made.

There are three boards which can be used together with **HPD-TA**: The Keithley GPIB board PC-488, the CTR05 trigger/counter board and the Data Translation Counter/Timer board DT2819. The default I/O address of the DT2819 is 560 decimal (230 Hex) and the default I/O address of the PC 488 is 696 decimal (2B8 Hex). These addresses should always be entered in decimal values. Instead of entering 696 for the PC 488, 0 can be specified to indicate the default setting. (This is **not** true for the DT2819).

The CTR05 board ID has to be set (normally to 0).

The section **External devices setup** tells the system which device types should be used and which devices and options are installed on these devices. Only one device of every device type (streak camera, spectrograph, delay unit) can be used at a time.

During start-up the program checks the entries and builds a **status/control box** for every device which is used. If there should be inconsistencies within the settings (e.g. if you specify that a GPIB cable is connected to a streak camera which does not have a GPIB interface) an error message will appear.

Automatic detection of plugin or options change

The program checks during start whether the saved configuration is still active. If a plugin/or options mismatch is detected the user is inquired whether he wants to continue the setup with the correct setup. This, of course, is dependent on the hardware. This feature is only available for some devices like the C5680 and only if the device is connected by GPIB. If any configuration mismatch has been detected a warning message will be displayed.

To ensure configuration mismatch problems you should consider following:

External devices controlled by the HPD-TA should be powered on **before** you start the HPD-TA software. If you specify wrong devices (specifically GPIB-controlled ones), or wrong GPIB addresses in the Device Control Setup, or if a device is not powered on at start-up or the GPIB cable is missing etc., the HPD-TA software may desperately try to communicate with the device. Depending on circumstances, this can lead to a situation where the HPD-TA is almost not responsive to user interactions any more (seems to be hanging).

Unless you fix the problem at the device's side, exiting and restarting the HPD-TA software will not solve the problem, since device configuration is automatically saved and re-loaded between sessions. If you cannot resolve a problem, please contact the Hamamatsu support office.

Getting Started

Overview

This chapter will describe first steps which may help you to start the system for the first time and to acquire your first images. If you want to know details of operations please refer to the detailed explanations in the following chapters.

Starting with the C4742-95 or C8800 Camera

This chapter refers to configurations which include a C4742-95 (ORCA or ORCA ER or C8800 camera.

When you start operating your **HPD-TA** system we recommend to become familiar with the camera **before** you operate the streak camera. You will operate your streak camera in a more **safe** manner if you are familiar with the readout system, its features and commands. The **risk to damage** the **streak camera** is smaller in such case. To do so it is best to connect an ordinary objective lens in front of the camera, focus a normal image on the camera and start the operation of the camera as shown below.

We assume that you have set up the camera as well as the frame grabber board and the **HPD-TA** program. For details, please refer to the camera manual and the chapter "Set-up and Installation" on page 13 of this manual.

Switch on the camera before you start the **HPD-TA** software.

Switch on the PC and start Windows. If **HPD-TA** is not yet installed under Windows, please do it now (refer to the Windows manual and the chapter "Software Installation" on page 14).

HPD-TA icon

Double-click the **HPD-TA** icon.

Starting HPD-TA

After the **HPD-TA** has been started the initialisation dialogue box will be displayed.

Now, please proceed with the initial system settings as described in the chapter "Initialisation" on page 20.

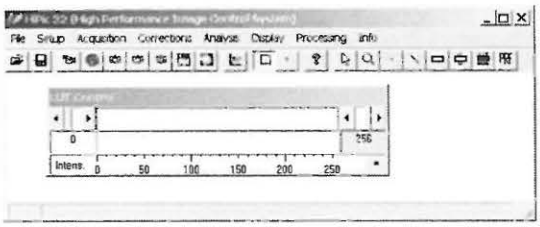
Now click the **OK** button of the initialisation dialogue.

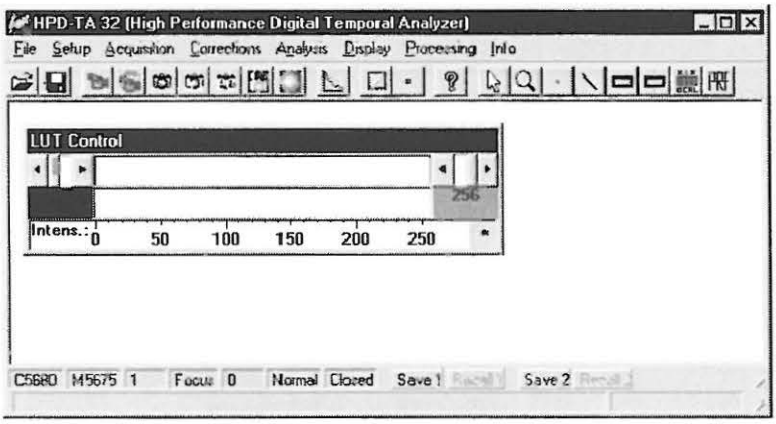
The main menu appears

After a few seconds **HPD-TA** will be initialised and the main menu (and perhaps a few other windows) will be displayed.

The main menu includes the following items:

File, Setup, Acquisition, Corrections, Analysis, Display, Processing and Info.



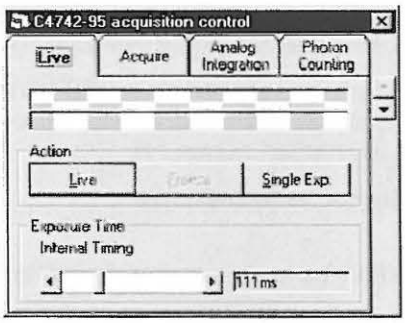


Main menu

Now you can start an image acquisition by executing the following commands:

- Click **Acquisition**. Now a command list will be displayed.
- Click **Live**. Now the Live mode dialogue will be displayed.

Or click  *to display the Live mode dialogue and click it a second time to start* ***Live*** *mode*



Live mode dialogue box

- The camera acquires images with default exposure time of 222 ms after you started the Live mode by clicking the **Live** button.

In order to get familiar to the basic camera features, we recommend to start with normal illumination conditions (daylight or bright field illumination) and put a standard optical lens in front of the camera.

If you have sufficient light, you may see an image now. You can e.g. set focus and aperture of your optical system or place the object under the camera now.

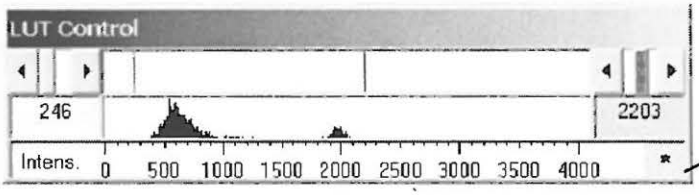
If the brightest parts of the image appear in red colour, the CCD detector is saturated. You should reduce the exposure time or the illumination level.

If you don't get a good image due to a too small amount of light, you should do one or several of following actions:

- Increase the exposure time of the camera with the slide bar **Exposure Time** in the Live mode dialogue box.
- Change the image contrast using the **LUT tool.**

LUT tool

After you started **HPD-TA** also the LUT (Look up table) tool is displayed.



Look up table tool

This tool controls the way how an image is displayed on the display screen. By converting grey values small changes of contrast can be enhanced.

*Click * *for automatic contrast enhancement.*

- By clicking at the right half of the top line of the LUT tool, a small red line appears, which will indicate the uppermost grey level of the contrast enhanced image. By dragging this line with the left mouse button pressed, the contrast will be increased or decreased.

Now you should be able to get first images with the camera. For details of camera settings, image processing and image storage commands, please refer to the sections below.

Important: Before you can start to use the complete streak camera system, you have to install the peripheral device drivers for the streak camera and accessories. Please refer to the chapter "Trigger setup " on page 76 for details.

Starting with the C4880 and C4742-98 Camera

This chapter refers to configurations which include a C4880 or C4742-98 (ORCA II) camera.

When you start operating your **HPD-TA** system we recommend to become familiar with the C4880 camera **before** you operate the streak camera. You will operate your streak camera in a more **safe** manner if you are familiar with the readout system, its features and commands. The **risk to damage** the **streak camera** is smaller in such case. To do so it is best to connect an ordinary objective lens in front of the C4880, focus a normal image on the camera and start the operation of the C4880 as shown below.

We assume that you have set up the camera with cooling and vacuum options as well as the frame grabber board and **HPD-TA** program. For details, please refer to the camera manual and the chapter "Set-up and Installation" on page 13 of this manual.

Please switch on the water-circulator (if you have a water-cooled camera type), the monitors and the camera.

Then switch on the PC and start Windows. If **HPD-TA** is not yet installed under Windows, please do it now (refer to the Windows manual and the chapter "Software Installation" on page 14).

HPD-TA icon

There are several ways of starting a program under Windows. Please use the way which is most convenient for you.

Click the **HPD-TA** icon.

After the **HPD-TA** has been started the initialisation dialogue box will be displayed.

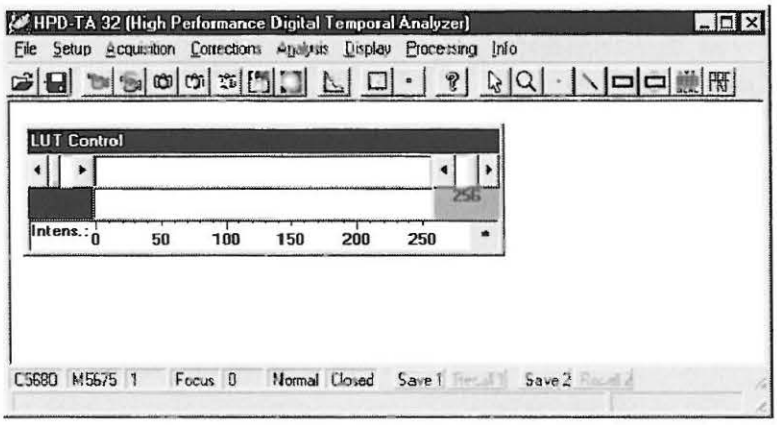
Now, please proceed with the initial system settings as described in the chapter "Initialisation" on page 20.

Now click the **OK** button of the initialisation dialogue.

After a few seconds **HPD-TA** will be initialised and the main menu (and perhaps a few other windows) will be displayed.

The main menu shows following items:

File, Setup, Acquisition, Corrections, Analysis, Display, Processing and Info.



Main menu

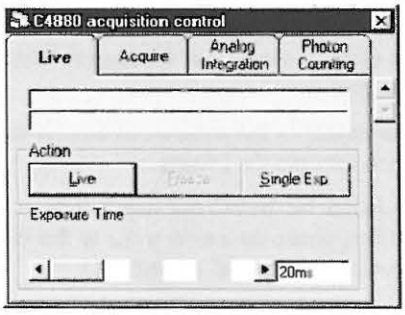
Now, you can start an image acquisition by executing the following commands:

Click **Acquisition**. Now a command list will be displayed.

Choose the **Live** command. Now the acquisition menu for fast scanning mode will be displayed.

*Or click .to display the Live mode dialogue box and click a second time to start **Live** mode immediately*

*The C4880 and ORCA II cameras allow to work with two different scanning modes. The fast scanning mode is mainly applicable for image adjustment (focusing), while the high precision mode is used for precise image acquisition. In **HPD-TA** the fast scanning mode is called "Live mode" and the high precision mode is called "Acquire mode".)*



C4880 Live mode dialogue box

- After clicking the **Live** button, the camera starts to acquire images continuously with the default frame exposure time of 200 milliseconds. (If you use a camera with mechanical shutter, you will hear the shutter of the camera operating with the frame rate). An image display box will be opened. However you may not see an image yet, especially if you work under low light level conditions. Also the cooler of camera does not work yet.

Freeze Live mode

- In order to stop acquisition, click **Freeze**. The last acquired image will be frozen.

In order to get familiar with the basic camera features, we recommend to start with normal illumination conditions (daylight or bright field illumination).
If you have sufficient light, you may see an image now. You can e.g. set focus and aperture of your optical system and place your object under the camera.

How to change the exposure time

- Click **Live** again and change the camera exposure time by clicking the arrow on the right (left) side of the **Exposure Time** slide bar. The camera exposure time is increased (decreased). Images get brighter (darker) on the monitor now.

If the brightest parts of the image are displayed in red, the CCD detector is saturated. You should decrease the exposure time or the illumination level.

You may now want to reduce the light level more and more in order to check the sensitivity of camera.

To get good image quality, you will have to increase the exposure time drastically (slide bar **Exposure Time**). However, before you do this you should switch on the camera cooler.

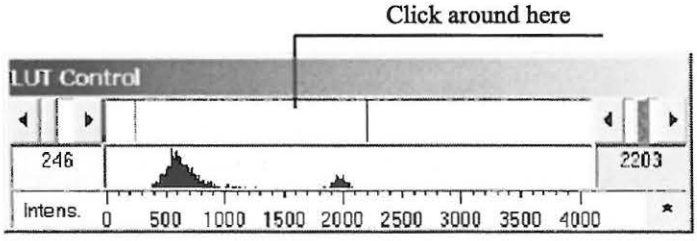
Attention!: Please check if the vacuum pump and the water cooler (in case of water cooling type) are switched on and work correctly before you turn on the camera cooler. Otherwise the camera will not cool down to the desired temperature and may be damaged in worst case.

- From the **Setup** menus select **C4880** (respectively **C4742-98)** to display the camera set-up box.
- Click the check button **Cooler on** in this menu. Now the cooler will work and cool the detector to the default target temperature of -30°C. For changing the target temperature, please refer to the chapter "Cooler and Temperature Control" on page 60.
- Then close the set-up menu again by clicking **OK**.

Now you can change the exposure time to long integration times. In fast scanning mode the exposure time is limited to 10 sec. If you can't see a good image even with a long exposure time due to the low brightness, you can try one or several of the following four methods:

- Change the camera gain to "High" by clicking the **High** button in the Live dialogue box. Now the camera operates with higher electrical gain.
- Change the image contrast using the **LUT tool.**

After you started **HPD-TA** the LUT (Look up table) tool was displayed.



Look up table tool

This tool controls the way how an image is displayed on the display screen. Small changes of contrast can be enhanced by converting grey values.

Click for automatic contrast enhancement

By clicking at the right half of the top line of the LUT tool, a small red line appears, which will indicate the uppermost grey level of contrast enhanced image. Shifting this line with the mouse (place the mouse above this line, press the left mouse button and shift the mouse to the left or right), the contrast will be increased or decreased.

Use the Superpixel mode of the camera by selecting **Super-Pix.** in the Live dialogue box **Scan Mode** frame. Now the camera adds the charge of 4 pixels into one pixel. The image will appear smaller on the monitor, but the camera sensitivity is increased.

Acquire mode

Change to **Acquire** mode and use a longer accumulation time. Under the **Acquire** mode much longer accumulation times are allowed. In order to change to **Acquire** mode, select the **Acquire** command from the **Acquisition** menu. Then the Acquire dialogue box appears. Now adjust the exposure time as you did in the Live mode and start an image acquisition by clicking **Acquire**. One image will be acquired.

Now you should be able to acquire your first images with the camera. For details of camera settings, image processing and image storage commands, please refer to the sections below.

Before you can start to use the complete streak camera system, you have to install the peripheral device drivers for the streak camera and accessories. Please refer to the chapter "Trigger setup " on page 76 for details.

Starting with an Analog Video Camera

This chapter refers to configurations which include an analog video camera.

When you start operating your **HPD-TA** system we recommend to become familiar with the camera **before** you operate the streak camera. You will operate your streak camera in a more **safe** manner if you are familiar with the readout system, its features and commands. The **risk to damage** the **streak camera** is smaller in such case.

We assume that you have set up the camera as well as the frame grabber board, the image display monitor and the **HPD-TA** program. For details, please refer to the camera manual and the chapter "Set-up and Installation" on page 13 of this manual.

Switch on the camera before you start the **HPD-TA** software.

Switch on the PC and start Windows. If **HPD-TA** is not yet installed under Windows, please do it now (refer to the Windows manual and the chapter "Software Installation" on page 14).

HPD-TA icon

Starting HPD-TA

Double-click the **HPD-TA** icon.

After the **HPD-TA** has been started the initialisation dialogue box will be displayed.

Now, please proceed with the initial system settings as described in the chapter "Initialisation" on page 20.

Now click the **OK** button of the initialisation dialogue.

The main menu appears

After a few seconds **HPD-TA** will be initialised and the main menu (and perhaps a few other windows) will be displayed.

Note: During initialisation the software will check if the camera delivers a video signal to the frame grabber. If not, a warning message will be issued. In this case you should check if the camera is switched on and all cable connections are made properly.
If you are sure that it is working, you can continue to open the program.Since in exceptional case the system may not detect a missing video signal and accordingly no warning message will pop-up during initialisation, we strongly recommend to do following procedure each time you start the program in order to check, if the camera really works as it should (in order to avoid any damage of the streak tube it is important to assure that the video system works correctly before you use the streak camera).:

-Open the program

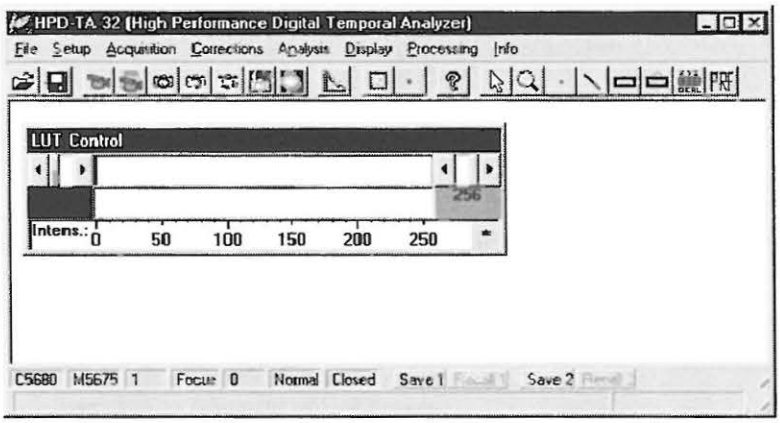
-Start camera Live mode (see below) without exposing the camera to light

-Stop Live mode

-Check the intensity histogram displayed in the lower part of the LUT tool (see below). If the histogram shows a maximum in the range of the intensity value 128, the camera does not deliver a proper signal to the frame grabber. In this case you should contact your system supplier to get further advise. If the histogram shows a maximum around the intensity value 10, the camera works correctly.

The main menu includes the following items:

File, Setup, Acquisition, Corrections, Analysis, Display, Processing and Info.

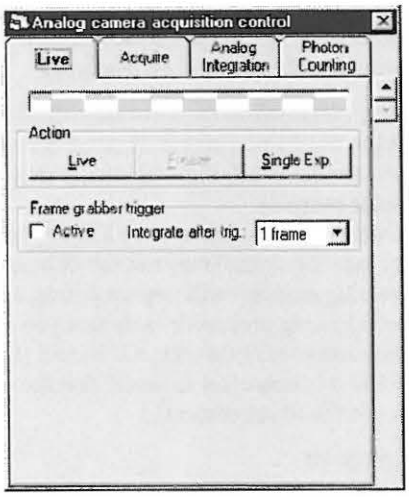


Main menu

Now you can start an image acquisition by executing the following commands:

- Click **Acquisition**. Now a command list will be displayed.
- Click **Live**. Now the Live mode dialogue will be displayed.

Or click  *to display the Live mode dialogue and click it a second time to start* ***Live*** *mode*



Analog video camera Live mode dialogue box

- The camera acquires images after you started the Live mode by clicking the **Live** button.

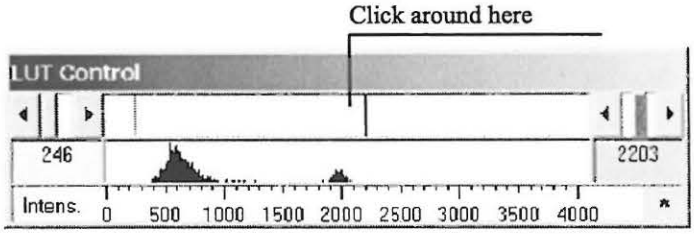
If the brightest parts of the image appear in red colour, the CCD detector is saturated. You should reduce the exposure time or the illumination level.

If you don't get a good image due to a too small amount of light, you can

- Change the image contrast using the **LUT tool.**

LUT tool

After you started **HPD-TA** also the LUT (Look up table) tool is displayed.



Look up table tool

This tool controls the way how an image is displayed on the display screen. By converting grey values small changes of contrast can be enhanced.

Click for automatic contrast enhancement.

- By clicking at the right half of the top line of the LUT tool, a small red line appears, which will indicate the uppermost grey level of the contrast enhanced image. By dragging this line with the left mouse button pressed, the contrast will be increased or decreased.

Now you should be able to get first images with the camera. For details of camera settings, image processing and image storage commands, please refer to the sections below.

Important: Before you can start to use the complete streak camera system, you have to install the peripheral device drivers for the streak camera and accessories. Please refer to the chapter "Trigger setup " on page 76 for details.

Command Overview

Following list shall give you an overview about the most important commands implemented into **HPD-TA** . Please refer to the following chapters where you find detailed descriptions of each command.

Command	**Function** (availability of several functions is depending on the camera and the frame grabber being used.)
Acquire Images	
Live	Continuous acquisition and display of images, control of exposure time, gain and scan mode (Superpixel, subarray, binning etc. C4880 cameras work in fast scan mode.
Freeze	Stops image acquisition in Live mode.
Acquire	Single shot image acquisition with high precision, control of exposure time, gain and scan mode (Superpixel, subarray, binning etc.). It is used for image acquisition with high accuracy. C4880 cameras work in slow san mode.
Analog integration	Accumulation of images in the frame-buffer. This mode is useful if the signal to noise ratio has to be improved by averaging.
Photon Counting	Acquisition of images in photon counting mode. This mode is useful when an image intensifier or a streak camera is put in front of the CCD camera. Single photon events can be detected if this device is operated at high gain. The photon counting mode allows to accumulate these single photon events.
Sequence	Acquisition of series of images, storage on computer memory (RAM) or hard disk. Sequence mode can be used if a sequence of images shall be recorded with a high frequency. This command includes also a sequence replay function.
Correct Images	

Background subtraction	This function allows to subtract a background image. This can be used to subtract cameras dark current.
Shading correction	This functions allows to correct the shading of images.
Curvature correction	This function allows to correct distorted images acquired with synchroscan streak cameras with synchronous blanking function.
Defect pixel correction	This function corrects defective pixel ("dead pixel, hot pixel")
Jitter correction	This function allows to correct jitter which is introduced at single shot streak mode. This function is included in the sequence control.
Average	This function allows to average images in the frame memory.
Correction set-up	Make settings for the image correction commands.

Optimise Image Display

LUT tools	This is a tool which is used to control the contrast of the displayed images on the screen.
Zoom	Images can be zoomed.

Analyse

Profile	Intensity profiles can be displayed and analysed. This function is used to analyse image data quantitatively. In order to allow measurement in physical units the data can be scaled. One intensity profile can be acquired in real-time (QuickProfile). Data can be exported by DDE links.
QuickProfile	A special intensity profile function, which can be used for real-time profile analysis
Histogram	Statistical analysis of intensity data.
Fitting (optional)	This function allows to perform fluorescence lifetime analysis. It requires the optional TA-Fit module.

Process Images

Arithmetic	Add, subtract, multiply or divide images, add offset signals etc. This function can be used to make calculations among images.
Superimpose	Overlay two images.
Framing>Sequence	Convert a framing camera image into an image sequence.

Save, Load and Print Images

Save As.., Save ROI As.., Open..	Commands to save and load images or image sequences in IMG, TIFF or other formats.
Print	Print images

System Set-up

Camera set-up	Make settings for the camera.

Scaling set-up	Prepare scaling data for physical scaling of images and intensity profiles.
Trigger set-up	Prepare streak triggering
Device control set-up	Make settings for the streak camera, plug-ins and system periphery.

We recommend that you read the chapters "Basic operations" on page 36 and "Setup menu" on page 56 now.

In the chapter "Basic Operations" you will find important basic information about the program. In the chapter "Setup menu" you will find a description about commands for system set-up. You should be familiar to these commands before you use the system intensively and make the set-up according to your system configuration.

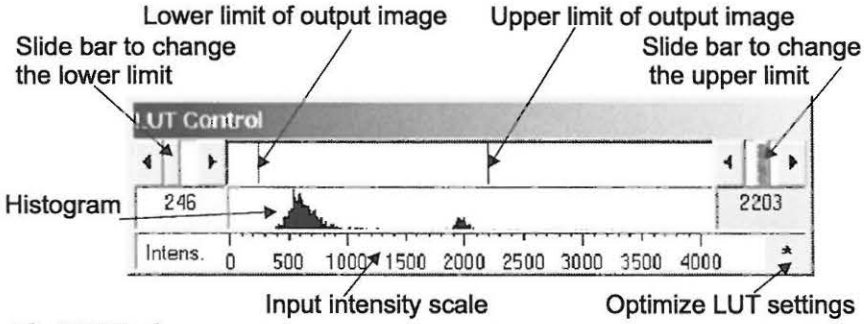
Basic operations

Overview

Several operation procedures and methods of **HPD-TA** are used throughout the whole program. You may need the tool for contrast enhancement (LUT) whenever you work with images. You may need the tools for selecting areas of interest whenever you have to limit a zone of an image. You will find a description about these basic operations in this chapter.

LUT Tool

The LUT tool is used to control the image display by manipulating its brightness and contrast.



The LUT Tool

LUT Tool

If you acquire images you will find that the images are frequently displayed with too low or too strong contrast. If you acquire images under low light level conditions the display may be too dark. Use the LUT tool to adapt the image display to the desired contrast. This is done by defining the lowest and highest grey value which shall be displayed.

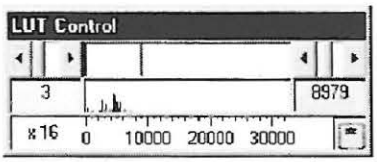
The tool contains an area with two cursors which represents a lower (blue cursor) and an upper limit (red cursor) for the LUT. The meaning of the values of these cursors is described below. The cursors can be moved by clicking next to them and dragging them while the left mouse button is pressed. When you use the right mouse button instead, both cursors will move simultaneously, keeping their distance constant. An alternative way to move the cursors is provided by the two sets of slide bars at the left and right side of the LUT tool. Two display boxes (blue and red) display the exact numerical values of the two cursors.

You can easily see how the image contrast is changed when you change the upper or lower limit as the current image is updated after any change in the LUT control.

The bottom part of the LUT shows a scale representing the input intensity values. In 8 bit mode the scale ranges from 0 to 255, in 10 bit mode from 0 to 1023, in 12 bit mode from 0 to 4095 and in 16 bit mode from 0 to 32767.

At the centre part of the LUT tool (above the scale) a histogram is displayed where the user can see the frequency by which intensity values are present in the image. This histogram can be used as a guide for setting the LUT limits.

The LUT tool is re-sizeable horizontally. If the LUT tool is longer, the intensity scale can be seen and accessed with higher precision but the histogram display will need more time to update.



LUT tool when using 32 bit image data files

When 32 bit image data file format is used (e.g. with 16 bit digital cameras) the string "x16" in the lower left corner of the window indicates that the intensity figures shall be multiplied by 16 to give the real intensity data values.

Upper and lower limits

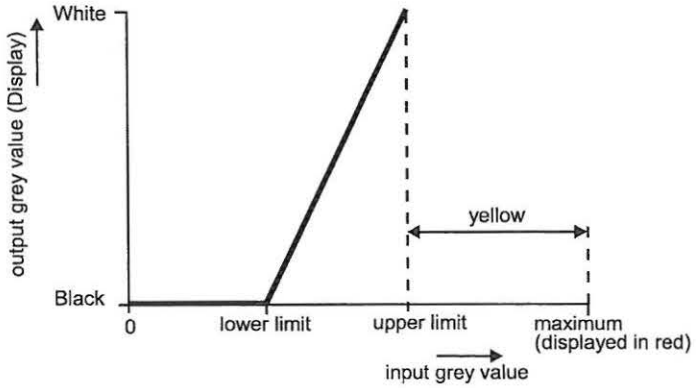
HPD-TA allows to display images either in black and white or in pseudocolour mode (see "LUT (Look up Table)" on page 172). The meaning of the LUT limits is explained below for both modes.

Intensity values between the lower and the upper limit are displayed using the full range of the LUT (either in grey-scale or in colour). The values above the upper limit (which exceed the current LUT) are displayed in yellow (in case of grey-scale LUT) or black (in case of colour LUT).

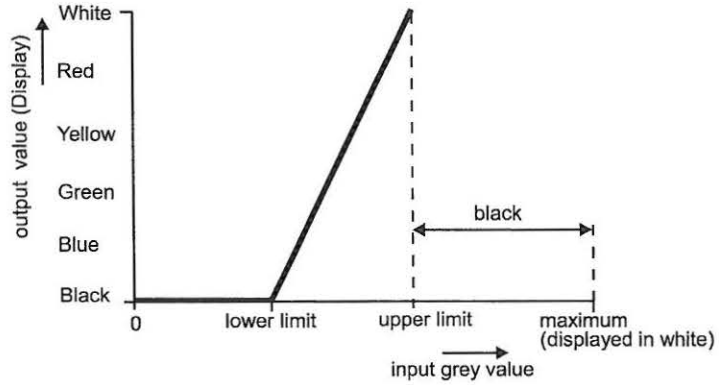
The uppermost intensity value of the current acquisition mode is displayed in red (grey-scale LUT) or in white (colour LUT). Areas in these colours indicate an overflow of the CCD camera. For 10 bit images the overflow value is 1023 and for 12 bit images it is 4095. Be sure to reduce your light intensity if you encounter this situation. Please refer to " Section Images" on page 89 for additional options of LUT usage.

Display mode	*Smaller than blue cursor*	*Between cursors*	*Greater than red cursor*	*Saturation*
B/W	*Black*	*Black to white*		*Red*
Pseudocolor	*Black*	*Blue to red*	*Black*	*White*
B/W without using colors	*Black*	*Black to white*	*White*	*White*

Table: Image colour-coding in different display modes



Mapping of LUT values for black and white LUT

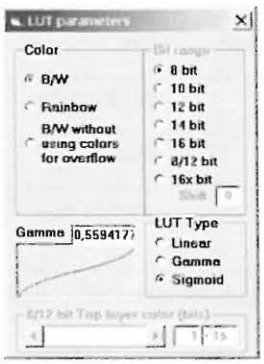


Mapping of LUT values for colour LUT

Non-linear contrast enhancement

The standard (default) enhancement mode offers a linear enhancement between the lower and upper limits.

However sometimes a non-linear enhancement function may be preferred. This program supports two non-linear modes: Gamma and Sigmoid.



LUT dialogue with linear contrast enhancement

In order to switch from the linear to a non-linear mode, you have to open the dialogue **LUT** in the **Display** menu. Click the option button of the enhancement function which you want to use in the **LUT Type** field. Then set the enhancement factor (gamma-factor or sigmoid factor) by clicking and dragging the enhancement curve in the graphic box. Alternatively you can insert the desired

factor into the textbox **Gamma**. Then press the enter key to activate the new factor and recalculate the image (see also „LUT (Look up Table)“ on page 172).

Optimize contrast enhancement

Automatic contrast enhancement

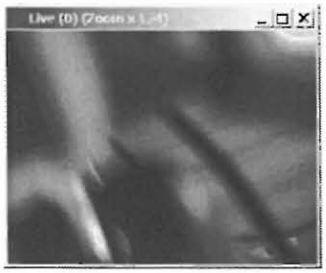
By clicking the small asterisk at the lower right side of the LUT tool or the corresponding button in the menu bar you can force LUT limits being calculated automatically according to the intensity values present in the image. In most cases this is an easy way to adapt the LUT settings to the current image and to obtain optimum digital contrast enhancement.

Image Display

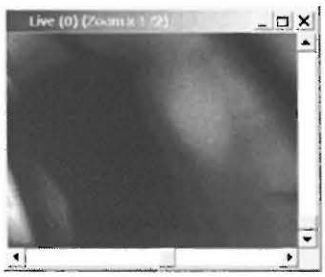
Up to 20 images can be displayed at a time. Each image has its own status. All image processing functions refer to the currently selected image (called "**current image**" in this manual). If you click to an image it becomes the current image.

Each image has its own properties concerning the LUT and colour selection. If several images are displayed on the screen and they have different colour selection, not all images may be displayed correctly. Normally only the current image is displayed correctly. This behaviour depends on the selected color depth of the Windows display.

The image is always displayed within a window with a specific zoom factor. Zoom factors from 1/8 to 8 are available. When the image with the current zoom factor does not fully fit into the window, scrollbars appear on the side and only a portion of the image is displayed (see "Zoom" on page 40).



The whole image displayed



Only a part of the image is displayed

When the window is larger than the area needed for the image a part of the window remains white.

When the image is smaller than the display window

You can freely select the size of the window. Sometimes one wants to set the window size to exactly match the image size. In such case it is sufficient to double-click to a grey area on the image window or to select the image and press the function key F2. When the window is smaller than the image there is a small grey area on the lower right corner where one can click.

The caption of the window contains information about the image (image mode, file name, zoom factor). Some functions resize the window automatically so that the image fits into the window automatically (e.g. Acquire, Open.., Background Subtraction).

Zoom

Zoom tool

When the Zoom tool is selected the left and right mouse buttons can be used to change the zoom factor. The zoom factor is increased by a factor of 2 when clicking with the left mouse button to the current image area. The zoom factor is decreased by a factor of two when clicking with the right mouse button.

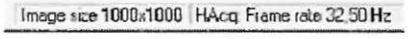
The zoom factor ranges from 1/8 to 8.

The point where the user clicks to the image becomes the centre point of the image. Thus when you want to magnify a certain location it is sufficient to click to this location with the left mouse button.

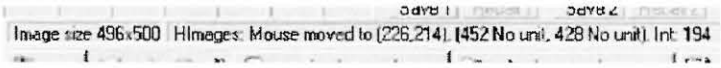
If there are scroll bars on the right or bottom side of the window, just a part of the image is displayed. The scroll bars can be used to scroll to a location which is currently not displayed. It is however more convenient to zoom out with the right mouse button until the portion of the image which should be displayed becomes visible. Then click to this location with the left mouse button to magnify it.

Status information

On the bottom part of the program window status information is displayed. The content depends on the actual conditions. E.g. during LIVE mode the actual frame rate will be displayed.



While the mouse cursor is inside of a image window, the co-ordinates and the intensity value at the current mouse position are displayed.



Status display including actual pixel intensity information.

Selecting Regions of Interest (ROIs)

Frequently you will have to select special areas on an image. For example you may sometimes want to save only a part of the image. In order to do this you will need a tool to select a special area of the image, a region of interest (ROI).

On the main window of **HPD-TA** there is a group of push-buttons which allow to set ROIs on the current image. These buttons are:

	Pointing tool
	Point ROI selection tool
	Line ROI selection tool
	Rectangular ROI selection tool
	ROI move and resize tool
	Display the ROI info

The **pointing tool** deselects all other tools and clicking with it in an image window erases the existing ROI.

ROI

You can select an individual ROI (Region Of Interest) for every image, but each image can have only one ROI at a time.

There are three types of ROIs: Point, Line and Rectangular ROIs. If a program function requires such a ROI you have to **select the correct ROI first** and then you can execute the function. If the wrong ROI type is currently selected the program issues an error message and the function does not execute. To specify a ROI proceed as follows:

Select the type of ROI by clicking to the icon on the main window tool bar.

Point ROI

Point ROI tool

Click at the desired point within the current image to select one pixel as ROI.

Line ROI

Line ROIs are straight (1-dimensional) lines with arbitrary start and end points. They are typically used for specifying the sampling line for a profile.

Line ROI tool

Place the mouse cursor at the place within the current image where your line-ROI shall start and press the left mouse button. Drag with the mouse to the desired end-point of your line ROI while you keep the left mouse button pressed. Release the mouse button. The selected line will be displayed overlaid to the image.

Rectangular Area ROI

Rectangular ROIs are rectangular (2-dimensional) areas. They are typically used when saving or loading images to/from disk, when generating histograms, and as sampling areas for vertical or horizontal profiles.


Area ROI tool

Place the mouse cursor at the place within the current image where your area-ROI shall start and press the left mouse button. Drag the mouse to the desired end-point of your ROI while you keep the left mouse button pressed. Release the mouse button. The selected (rectangular) area will be indicated by a frame.

Note: If you have selected a ROI, it will stay there (even if the ROI border is not displayed) until you select another ROI or erase the ROI by clicking the pointing tool.

For image processing functions which require an rectangular ROI the program behaves as follows: When no rectangular ROI is selected the whole image area is used for the processing, when a rectangular ROI is selected this ROI is used.

Move and Resize a ROI

Select the Move and resize tool to change an already defined ROI.


Move and resize ROIs tool

In order to move an existing ROI, place the mouse cursor within the ROI (Area) or next to the ROI (Line) and press the left mouse button. Than you can drag the ROI to another location.

In order to change the size of an ROI, place the mouse cursor near the ROI and press the right mouse button. As soon as you move the mouse while keeping the mouse button pressed, the lower edge of the ROI will be "attached" to the cursor. You can now change the size as desired. (Not functional for point ROIs, of course.)

Alternatively a ROI can be shifted by using the cursor keys (left, right, up, down). Each time you press one of the keys the ROI is shifted by 1 pixel. If you press the CTRL key + one of the cursor keys, the ROI is shifted by 10 pixel, if you press CTRL+ALT + one of the cursor keys, the ROI is shifted by 100 pixel.

If you press the Shift key + one of the cursor keys, the lower right corner will be shifted (ROI size is changed).

If you want to expand an ROI over the entire horizontal or vertical image area, you can select an ROI and press H to extend the ROI over the maximum horizontal area, or V to extend it over the maximum vertical area, or F to extend it over the full image.

Alternatively the Display ROI information tool can be used to set the size and position of a ROI.

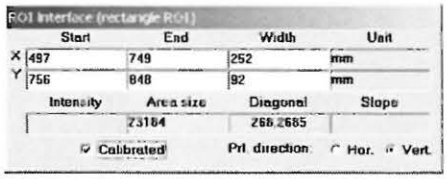

Display ROI info tool

If an ROI is currently displayed on the screen, you can open the ROI interface dialogue box by clicking the Display ROI tool. Select the ROI parameter which you want to change by clicking with the left mouse button. Then type the desired number. Repeat this for all numbers you want to change.

This way of changing the ROI size and position is especially useful when you want to set the window very precisely (with an accuracy of one pixel).

Display ROI data

Display ROI information tool



ROI info dialogue box (example: Area ROI)

Select the Display ROI tool to display a dialogue box where several data about the currently selected ROI are displayed. These data are:

X and Y position and intensity data in case of a point ROI.

X and Y co-ordinates of start and end point as well as length of the ROI in case of a Line ROI.

X and Y co-ordinates of the edges of the ROI, the ROI area and the length of ROI diagonal in case of an Area ROI.

Select the **Calibrated** checkbox if you want to display the data with scaling information (see also "Scaling Set-up" on page 64.

The radio buttons **Prf. Direction Hor. / Vert** allow to choose the direction of the QuickProfile analysis (see "QuickProfile" on page 43).

QuickProfile

With the QuickProfile function an intensity profile can be analysed and displayed in real-time. It is available during Live mode but also at any other time. The profile is displayed as an overlay to the current image.

QuickProfile button

While the **Live** mode is running, but also during or after execution of another image acquisition mode, a QuickProfile can be displayed. This is especially useful for focusing and set-up purposes. When you want to display a QuickProfile select a rectangular ROI in the current image window. After pushing the QuickProfile button the profile will be displayed. It is overlaid with the image. Only integrated horizontal or vertical profiles can be selected for the QuickProfile.

In order to decide the profile direction, you have two possibilities:

- Default direction setting
  Default setting can be made in the **Options/ Acquisition and Display** dialogue(see "Section Acquisition" on page 88).
- Online setting
  Open the Display ROI info window by pressing the Display ROI info button. Select the checkbox **Def. Direction Hor.** or **Ver.** for the actual intensity display.

If there is an intensity distribution within the ROI which shows a clear intensity maximum, the QuickProfile function tries to calculate the FWHM (Full width at half maximum) value of this light peak. The result will be displayed on the left upper corner of the image.

The QuickProfile will be automatically scaled in a way that the intensity value given by the lower limit of LUT setting is displayed on the bottom of the image (left of the image in case of a vertical profile) and the upper limit of LUT setting is displayed on the top of the image (right of the image in case of a vertical profile).

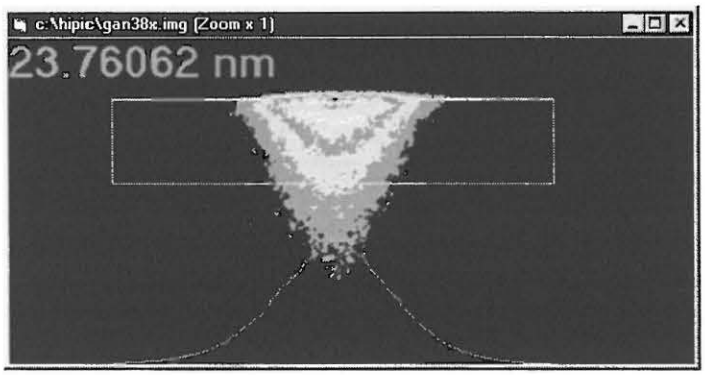


Image with QuickProfile

A horizontal profile is displayed horizontally, a vertical profile is displayed vertically.

General Comments on Image Acquisition

Note: You do not need to read this chapter to understand the basic program operation but you should read it if you want to get a deeper understanding of scaling, shading correction and frame-buffer organisation.

Camera and Frame-buffer

To understand what happens during data acquisition it should be distinguished between two objects:

- The camera delivering the image.
- The frame-buffer which stores the image and displays it.

The **camera** has two dimensions (X and Y) and a data depth. Here are some examples:

An analog camera such as the Hamamatsu C3077 has an 8 bit data depth and a size of 768 x 572. The C4742-95 has a data depth of 12 bit (depending on the acquisition mode) and a size of 1344 x 1024 pixels.

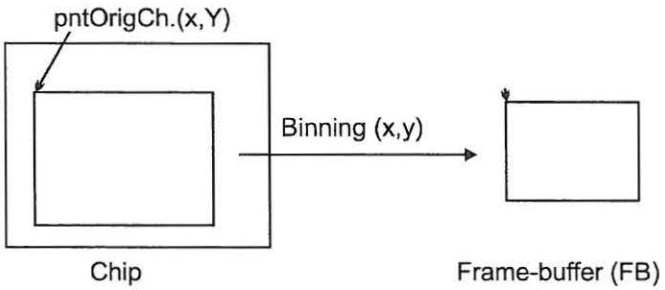
The **frame-buffer** has an overall data depth of 8, 16 or 32 bit and an area m x n pixel. The frame buffer is always located in the PC memory.

How Areas are Transferred from Camera to Frame-buffer

As these two objects are not identical in their general organisation structure, we have to know how an image from the camera is transferred to the frame-buffer. Therefore we define the following numerical parameters:

`pntOrigCh.X`	The origin of the image on chip (X-direction)
`pntOrigCh.Y`	The origin of the image on chip (Y-direction)
`pntBinning.X`	Binning factor in X-direction
`pntBinning.Y`	Binning factor in Y-direction
`areSource.X`	Area on the frame buffer (X starting value)
`areSource.Y`	Area on the frame buffer (Y starting value)
`areSource.DX`	Area on the frame buffer (Width in X direction)

`areSource.DY` Area on the frame buffer (Width in Y direction)



Area definitions used in **HPD-TA**

The image which is read out starting at the location pntOrigCh (X,Y) on the chip is transferred to the frame-buffer. If binning is active the image is reduced in size according to the binning factors in both dimensions. If one knows the a.m. numbers the chip origin of every pixel in the frame-buffer can be calculated. This is especially necessary for scaling and shading correction:

- When assigning a scaling to the system, every pixel on the chip is assigned a scaled value in both dimension. For obtaining the scaled information the pixel origin on the chip must be known.
- Shading correction is a correction of different sensitivity of the overall system at every pixel on the chip. The correct origin on the chip must be known for areSource in this case.

The "areSource" values describe the image area on the frame-buffer which contains a valid image. If only a part of the image is saved, these values are modified accordingly.

You can open the **Image Status** dialogue box (see "Image Status" on page 55) to view the parameters of a image.

Note: If the frame grabber memory is not large enough to handle the entire image of your sensor, a smaller part of the image will be acquired starting from the top left corner. You will see this on the status bar during acquisition.

Considering 8, 10, 12, 14, 16 and 32 bit Images

Depending on the camera and the acquisition mode the image has a certain data type (data depth). The IC-PCI acquires images which are 8, 10, 12, 14 or 16 bit deep. Only 16 bit images can have negative values (signed data type). During background subtraction values are clipped to zero or negative values appear. This is depending on the setting **Clip to zero during background sub.** in the section **General** of tthe **Setup – Options** dialogue (see also "Section General" on page 86). 8 bit images are always clipped to zero during background subtraction.

The data types of images are as follows:

Mode	Data Type
Live	8 bit (analog cameras), 10 or 12 bit (according to the camera version)
Acquire	8, 10, 12,14 or 16 bit according to the camera version
Analog integration	16 or 32 bit

Photon Counting	16 bit

The data itself are stored either in 8, 16 or 32 bit.

If the camera outputs 16 bit images the resulting images will be always 32 bit images (to allow to store signed values). There is also an option to force the creation of 32 bit images in Analog Integration mode (see "Section Acquisition"on page 88).

Error Handling

Though the program is carefully designed, planned, coded, tested and debugged, software which exceeds a certain amount of code cannot be absolutely bug free in every circumstances and with all available parameter settings. As a consequence this program also may have certain bugs which are not detected during test but which may appear at customers site. To allow easy debugging and ensure program quality a powerful error handler has been established within this program. When a fatal error occurs the chain of function calls and other important data is written to a file before the program is ending. This file can be used to locate the origin of the error as quickly as possible.

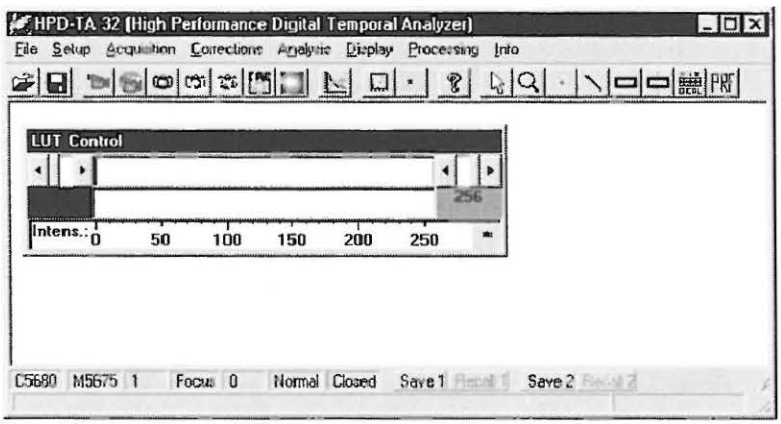
When such an error occurs a message-box appears informing the user that such an error has appeared and all information has been written to the file **ERRORS.TXT** within the directory in which the programs EXE file is located. If such bug has occurred at your side please send this file to your local **Hamamatsu** dealer.

In the following sections of this manual you will find detailed descriptions about the commands of the program. You may not need to read them, as long as you do not have specific questions about details of a command. However you should read the chapter "Setup menu" on page 56 before you use the system extensively and make the set-up according to your system. In the chapter "Setup menu" you will find a description about commands for system set-up. You should be familiar with these commands .

Application Control Window

Application Control Window

After you clicked **OK** in the initialisation dialogue box (see "Starting the program" on page 20) the application control window will appear.



Application control window

The application control window contains the menu bar, a tool bar and a status bar on the bottom of the window.

In the status bar messages about the status of the action under progress (e.g. "Save image file xxxx") and other important system status parameter will be displayed. If an image is loaded it also contains the size of the image in pixels.

This includes information about the streak camera status, such as:

Camera type, plug-in type, time range, operation mode, MCP gain, gate mode and shutter status of the streak camera shutter.

The buttons **Save 1** and **Save 2** can be used to save two settings of external devices. All settings of all external devices are saved. Press **Recall 1** or **Recall 2** to recall these settings at any time. For example, this can be used to save a typical setting for focus mode under **Save 1** and a typical streak sweep setting under **Save 2**. It is easy to switch between these two modes. **Menu Bar**

In the Application Control windows menu bar you find following topics:

File, Setup, Acquisition, Corrections, Analysis, Display, Processing, Window (only if at least one image is displayed) and **Info**

The **File** menu offers commands for saving and loading images, for displaying the status of the current image and for exiting the program.

The **Setup** menu offers commands for control of the overall behaviour of the system.

The **Acquisition** menu contains commands for image acquisition.

The **Corrections** menu contains commands for image data corrections

The **Analysis** menu contains commands for analysing image data.

The **Display** menu controls properties of the image display on the monitor.

The **Processing** menu contains commands for processing image data.

Under the **Window** menu the open images are listed.

The **Info** menu provides information about the program including its version number and its status.

Tool Bar

The tool bar includes several push-buttons for execution of frequently used functions. These functions are:

Icon	Name	Description / Where to find a detailed command description
	Open image file	The **Open Image** dialogue will be displayed. See "Open" on page 54.
	Save image file	The **Save Image as..** window will be displayed. See "Save As .." on page 50.
	Live mode	If the Live mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Live mode dialogue box is open, image acquisition in **Live** mode will be started. The acquisition parameters as shown in the Live mode dialogue box are used.
	Freeze Live mode	**Live** mode stops. The last image will be stored.
	Acquire	If the Acquire mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Acquire mode dialogue box is open, an image acquisition in **Acquire** mode will be executed. The acquisition parameters as shown in the Acquisition mode dialogue box are used..
	Analog integration	If the Analog integration mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Analog integration mode dialogue box is open, an image acquisition in **Analog integration** mode will be executed. The acquisition parameters as shown in the Analog integration mode dialogue box are used.
	Photon counting	If the Photon counting mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Photon counting mode dialogue box is open, an image acquisition in **Photon Counting** mode will be executed. The acquisition parameters as shown in the Photon counting mode dialogue box are used. See "Basics of the Photon Counting Mode" on page 96.
	Background subtraction	A background subtraction will be executed. See "Background Subtraction" on page 147.
	Shading correction	Shading correction will be executed. See ""Shading Correction" on page 147.
	Profile Analysis	The Profile analysis window will be opened and displayed in the foreground. See "Profile" on page 159.

	LUT	The LUT tool will be displayed. See "LUT Tool" on page 36.
	Auto LUT	Automatic contrast enhancement will be made.
	About	The About window will be opened. See "Help About" on page 182. If you select the Help menu, the help file will be opened. This is a Adobe Acrobat file in PDF format. You need to have Acrobat Reader installed to read the file. You can find a copy of the Acrobat Reader on the installation disk.
	Pointing tool	This tool is used for de-selecting the other ROI tools and for erasing an ROI from an image. See "Basic operations" on page 36 to learn details about this and the following tools.
	Zoom tool	If the cursor is within an image area, it will be used as zooming/dezooming tool.
	Point ROI selection tool	If the cursor is within an image area, it will be used to select an point as area of interest.
	Line ROI selection tool	If the cursor is within an image area, it will be used as tool to select a line as area of interest.
	Rectangle ROI selection tool	If the cursor is within an image area, it will be used as tool to select a rectangular area of interest.
	Modify ROI	If you set the mouse cursor within an ROI and press the left mouse button, you can change its position, if you press the right mouse button, you can change its size.
	ROI data	A dialogue box will be opened where information about the currently selected ROI is displayed (position, size).
	QuickProfile	After selecting a rectangular ROI, the QuickProfile tool can be used to display a intensity profile overlaid with the image data. This profile is also continuously updated during image acquisition. **Note**: Depending on the system configuration some of these push-buttons may not be visible (e.g. if you choose the "No frame grabber mode" the push-buttons related to acquisition are not visible: Live, Freeze, Acquire) .

File Menu

Overview

The **File** menu contains the topics **Open..., Save As..., Save ROI As..., Print, Image Status** and **Exit**.

File menu

Save As .. and Save ROI As ..

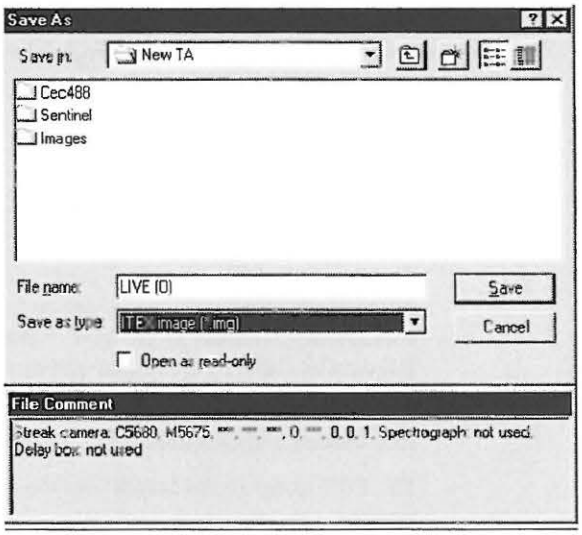
*The **Save As..** command opens a dialogue box where you can input file name, file type, drive and directory name for the image file to be saved. The complete image will be saved.*
*The **Save ROI As**.. command saves the partial image within the currently selected rectangular ROI .*

Save As.. tool

Choose **Save As...** from the **File** menu.

*Define the image area (ROI) which shall be saved before you invoke **Save ROI As...***

If you want to save a part of the image only, you have to select the ROI **before** you open the **Save ROI As...** dialogue box (see also "Selecting Regions of Interest (ROIs)" on page 41)!



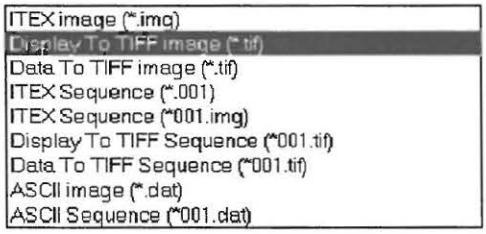
Save As... dialogue box

If you select **Cancel** the program cancels the operation.

The dialogue box behaves like a standard Windows dialogue box. It allows to select the directory where the file shall be saved, to define new directories, to display the file list in different formats etc.

After selecting the desired directory, you have to type the desired file name in the **File name** textbox.
Note: The correct file extension (e.g. ".tif" or ".img") will be automatically appended to the file name. If you type a file extension which is not identical to the file extension as defined by the file type (e.g. you type "image.pix"), the correct file extension will be appended automatically (e.g. "image.pix.tif").

Image data are saved in a format as selected in the **Save as type** list. Following formats are supported:



Save as type list

The file formats for image sequences will be available only, if the current image is a sequence image.

- ***ITEX image(*.img format).***
  This is one of the standard image formats (the other standard format is "Data to TIFF image") which maintains the full information of all images and is compatible with all data processing functions of this program. If it is not intended to export image data to other programs, we recommend to use this format. See "Appendix B: Image File Format" for details of the file format.

  Notes: If a camera with 16 bit data output is used, the image files will be saved in 16bit/pixel format. Images saved in the 32 bit data format can not be loaded in software versions lower than 6.1.

- ***TIFF format***

TIFF *(Tagged Image File Format) is a widely used image format and supported by most image-processing and word-processing software packages.*

HPD-TA also supports this file format. Two types of TIFF files can be generated:

- ***Display to TIFF image***
  If ***Display to TIFF image*** *is selected, a (palletised)8 bit TIFF image will be saved.*

  Note: Display to TIFF will reduce the bit depth of the images!

  The function of this command is to create a TIFF file which **looks** exactly like the image which you see on the display screen, including contrast enhancement by the LUT. It does, however, **not** contain the full data bit depth of the image, and hence it should not be used to store measurement results for other than display purposes.

  ROI overlay and QuickProfile will not be saved.

  The TIFF image looks exactly like the image which you see on the monitor.

  Note: If you want to load TIFF images within this program later on, always use the **Data to TIFF image** format.

  *If you want to store **HPD-TA** image data in another file format than IMG or TIFF, save them as TIFF first and use a graphic program (PhotoShop, Paint Shop Pro, Corel PhotoPaint) to convert the format.*

  Note: If the current image is part of a sequence, you have the choice, if you want to save the full sequence or only the current image.

- ***Data to TIFF image***
  Data to TIFF image *allows to save image data with full data depth in TIFF format. The file will contain 8* ***or 16 bit*** *data without the LUT transformation.*

  Note: Though 16 TIFF files are true TIFF files according to their definitions, not many other programs support this relatively new data format yet. If you are not sure whether your image analysis program can handle these files try it and use standard TIFF, as generated with the **Display to TIFF image** in the case your program cannot handle them.

  Images stored in 32 bit format will be saved in 16bit/pixel format. Most upper 16 bits are used. Lower bits are skipped.

  Note: If the current image is part of a sequence, you have the choice to save the full sequence or only the current image.

- ***ITEX*** Sequence
  This command allows to save a sequence of images which has been previously recorded with the ***Sequence*** *function (see* "Sequence" on page 129).

  You have to choose the name for the first image in the sequence. The system will ***automatically*** name all other images. Sub-areas of images (ROIs) can be selected.

Choose a file name according to the sequence image naming convention.

Note: There are two naming conventions for naming a sequence: NAMEXXX.IMG and NAME.**XXX** where XXX is a numeric expression (e.g. 001). See also chapter "Sequence image file naming conventions" on page 134.

Select the file format ITEX Sequence (*001.img) to save a sequence in the format NAMEXXX.img.

Select the file format ITEX Sequence (*.001) to save a sequence in the format NAME.XXX. **Note**:This format may not be supported in future versions of this program. It is only provided for compatibility reasons with older program versions!

If you do not add any numbers to the file name, the program will automatically add numbers.

TIFF Sequence

HPD-TA also supports TIFF file format for image sequences. Two types of TIFF file sequences can be generated:

- ***Display to TIFF Sequence***

  If **Display to TIFF Sequence** *is selected, 8 bit TIFF files will be saved.*

Note: Display to TIFF will reduce the bit depth of the images!

The function of this command is to create a sequence of TIFF files which **look** exactly like the images which you see on the display screen, including contrast enhancement by the LUT. They do, however, **not** contain the full data bit depth of the original images, and hence this format should not be used to store measurement results for other than display purposes.

*If you want to store **HPD-TA** image data in another file format than IMG or TIFF, save them as TIFF first and use a graphic program (PhotoShop, Paint Shop Pro, Corel PhotoPaint) to convert the format.*

Note: If you want to load TIFF images within this program later on, always use the **Data to TIFF image** format.

The sequence will be recorded in the naming convention NAMEXXX.tif.

- ***Data to TIFF Sequence***

  Data to TIFF Sequence *allows to save image sequence data with full data depth in TIFF format. The files will contain 8* ***or 16 bit*** *data without the LUT transformation.*

  Note: Though 16 bit TIFF files are true TIFF files according to their definitions, not many other programs support this relatively new data format yet. If you are not sure whether your image analysis program can handle these files try it and use standard TIFF, as generated with the **Display to TIFF Sequence** in the case your program cannot handle them.

  Images stored in 32 bit format will be saved in 16bit/pixel format. Most upper 16 bits are used. Lower bits are skipped.

  The sequence will be recorded in the naming convention NAMEXXX.tif.

- ***ASCII image***

  Image data can be saved in ASCII format. The data are stored without

any header information. Each pixel data is separated by a TAB character. The end of each line is indicated by carriage return + line feed.

The data can not be read by this program. ASCII files can be read by many spreadsheet programs like Excel and data analysis programs like Origin.

The extension *.dat is used for indicating ASCII image files.

- ***ASCII Sequence***
  Image sequences can be saved in ASCII format using this format. The data are stored without any header information. Each pixel data is separated by a TAB character. The end of each line is indicated by carriage return + line feed.

  The data can not be read by this program. ASCII files can be read by many spreadsheet programs like Excel and data analysis programs like Origin.

  The naming convention NAMEXXX.dat is used for this file format.

- ***DPC image file***
  The DPC file format is a special file format for photon counting images. The x-y co-ordinate of each photon and the time when it was detected is stored in these files. The file format selection *.dpc is only available when DPC-type photon counting images are generated (for details also refer to "Basics of the Photon Counting Mode" on page 96).

- ***HIS image sequence file***
  The HIS format is used for image sequences acquired with the fast hard disk recording mode. A full image sequence is stored in one single file. Please refer also to "Setting the acquisition parameters" on page 129.

File Comment

In the text box below the **Save As..** or **Save ROI As...**dialogue you can input a comment. This comment will be saved to disk together with the image file and it can be used to identify the image later on.

Open...

This command allows to load and display an existing image file.


The Open.. tool

The **Open...** command pops up a dialogue similar to the **Save As...** dialogue. You have to select an image file type which you want to load and display. To select a file you can either input a file name in the file name text box or double-click on the filename in the file list.

If the selected file is part of an image sequence, the sequence, starting at the chosen file number will be loaded.

Following file types can be read by this program:

ITEX files and sequences, TIFF files and sequences (however not 24 bit colour TIFF images), DPC files and DPC sequences (see "Dynamic Photon Counting (time resolved 2-D photon counting)" on page 99).

File info

As soon as you have selected a file, detailed information about the actually selected file will be displayed in the **File info** table below the dialogue box. The contend of this dialogue is same as the **Image Status** display explained below.

Print...

If you choose this command, the current image will be printed on your printer.

Image Status

*The **Image Status** command displays a window with the image status information of the current image.*

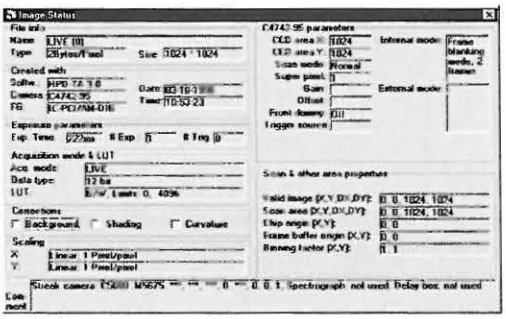


Image status control box

Exit

*The **Exit** command terminates the program unconditionally.*

Most set-up parameters will be automatically saved to disk and re-activated when the program is started the next time.

Setup menu

Overview

*In the **Setup** menu you find all entries for setting of the system parameters. You should read this chapter before you start to use your system extensively. You may have to change some of the settings before you can work with your system properly.*

The **Setup** menu has the following entries:

Camera(Analog Camera, C4880, C4742-95, C4880-8x, C4742-98 depending on the camera selected in the initialisation setup**), Scaling, Scaling File Editor, Trigger setup, Device Control Options..., Show Streak status/control, Show Spectr. status/control, Show Delay status/control, Emergency!, Framing camera** and **Options.**

Setup menu

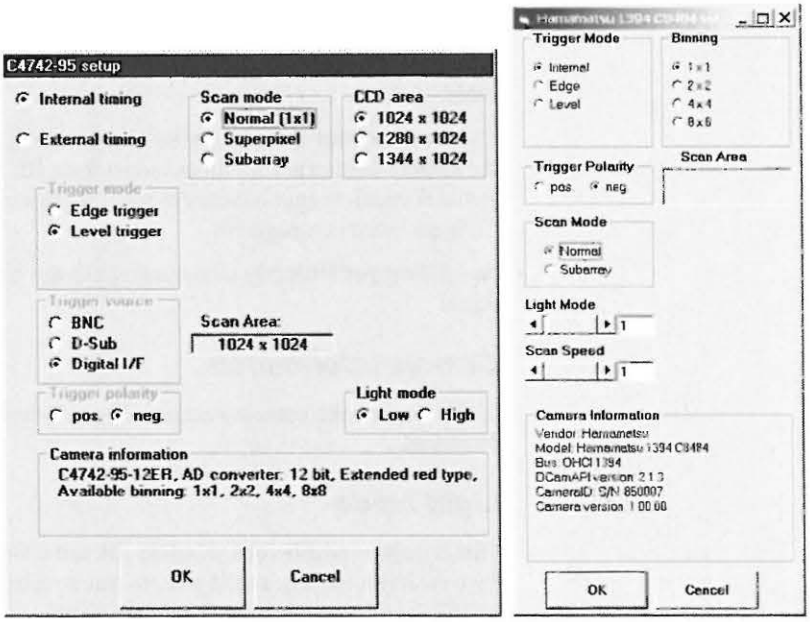
C4742-95 Set-up

***Note:** This menu is available if a black and white C4742-95 or C8484 type camera is used.*

Some parameters may sligtly differ depending on the camera version used. The menu may also look different depending on the driver version you use (internal driver or DCAM driver)

In the C4742-95 set-up dialogue box several parameters of the C4742-95 camera can be set.

Choose **C4742** in the **Setup** menu to display the C4742-95 set-up dialogue box.



C4742-95-12ER camera set-up dialogue box, Internal driver mode (left), C8484 camera set-up dialogue in DCAM driver mode (right)

Several basic settings of the camera can be selected here. The user normally wants to select these settings once and keep them for some time. Therefore these settings are stored and automatically used for your next session with **HPD-TA** .

CCD area

You can select if the full CCD area of 1344 x 1024, a field of 1280 x 1024 or if only a square of 1024 x 1024 pixel shall be used.

Scan Mode

The camera operation can be switched between **Normal** mode (full resolution), **Superpixel** mode (then one of 3 Binning modes can be selected) and **Subarray** mode (then readout area can be user-defined). Note: Subarray mode is only available if it is supported by the camera version.

Binning

Different binning formats can be selected. This is only available if **Superpixel** or **Subarray** mode is selected

Timing

If **Internal timing** is used the exposure time is controlled from the computer and the start of exposure from the camera, if **External timing** is used, exposure time and/or start of exposure is generated by an external trigger signal (please refer also to the camera manual).

If **External timing** is selected, two external trigger modes can be selected: **Edge** or **Level** triggering (please refer to the camera manual for a detailed description). In **Edge trigger** mode the start of an exposure is defined by an external trigger. The exposure time is defined by the program.

In **Level trigger** mode, start of an exposure and exposure time are defined by an external trigger signal.

If **External timing** is selected, there may be up to three ways to supply the trigger signal to the camera (**Trigger source**). Select **BNC** to supply the signal to the BNC connector at the camera control unit. Select **D-Sub**, if the signal shall be supplied to the D-Sub connector at the camera control unit. Select **Digital I/F**, if the signal shall be supplied from the computer via the digital camera cable.

Choose **External timing, Level trigger** and **Digital I/F,** if you need to use the camera with exposure times longer than 10s. This mode is automatically selected if streak trigger handshake with "Enclosing method" is selected (see also "Trigger setup" on page 76).

Select **Trigger Polarity** in accordance to the electrical polarity of your trigger signal.

Camera information

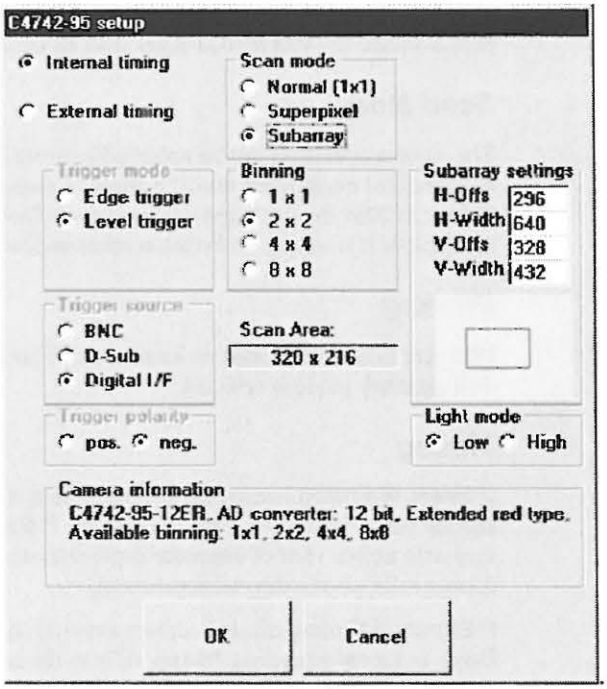
In this textbox the camera version and some important features of the camera are displayed.

Light mode

This is only available for C4742-95 ER and C8484 camera models.
Two different settings of the camera can be selected. In Light mode **"Low"** (="0") the camera works with reduced sensitivity but maximum dynamic range, while in Light mode **"High"** (="1") the camera works with maximum sensitivity at a slightly lower dynamic range (please refer also to the camera manual).

Subarray mode

In subarray mode the dialog box changes slightly. You can now select the portion of the image to be read out from the camera. This reduces the amount of image data to be handled. The smaller the subarray area, the higher is the camera frame rate.



C4742-95-12ER setup dialogue in subarray mode

Select the CCD area which shall be read out either by typing the desired values in the **Subarray settings** sections or draw a rectangle in the area below the

Subarray settings section. Have the left mouse button pressed while you drag from the upper left corner to the lower right corner of the desired readout area.

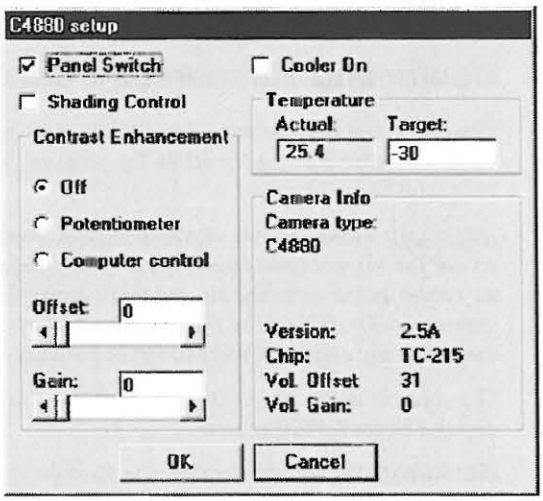
Press the **OK** button when you have finished your choice. Now the settings come into effect.

C4880 Set-Up

Note: This menu is only available if a C4880, C5987, C6918-05 or C7190-10 type camera is used!

In this dialogue box several operation parameters of the C4880 camera can be set. Please refer also to the C4880 manual.

Choose **C4880** from the **Setup** menu to display the C4880 set-up display box.



C4880 set-up control box (standard)

Analog Contrast Enhancement and Shading Control

By clicking the **Panel Switch** check box, you can specify whether the panel switch on the C4880 shall be active or not. If it is selected the control on the front panel of the C4880 is active (default). Normally you may not need to use the panel switch.

Shading correction and analog contrast enhancement are only effective in Live mode.

The C4880 cameras offer an analog shading control feature for the fast scan mode. It can be used to correct uneven illumination to a certain degree. If the **Shading Control** check mark is selected the four potentiometers SHADING on the right side of the C4880 controller are active for the Live mode (fast scan mode).

The C4880 cameras also offer an analog contrast enhancement feature for the fast scan mode. It may be used if very strong contrast enhancement is needed by the application (e.g. brightfield or DIC microscopy). Usually the digital contrast enhancement function of HPD-TA (see "LUT Tool" on page 36) is sufficient.

With the radio-buttons within the **Contrast enhancement** frame you can select whether or not the contrast enhancement is active for the Live mode (fast scan mode) and by which means the contrast enhancement is controlled.

- When the **Off** radio button is selected the contrast enhancement is switched off.
- When the **Potentiometer** radio button is selected the contrast enhancement is controlled by the potentiometers located in the middle part of the C4880 controller front panel.
- When the **Computer control** radio button is selected the contrast enhancement can be controlled by the two slide bars **Offset** and **Gain** below the **Computer control** radio button.

Note: For streak measurement we recommend not to use these analog enhancement functions (shading and contrast). It is generally better to perform similar tasks by means of the digital functions implemented in the **HPD-TA** software as explained in the chapter "LUT Tool" on page 36.

Cooler and Temperature Control

Please ensure that the vacuum pump and/or water cooler is/are switched on before you switch on the camera cooler.

The check box **Cooler on** selects whether the cooler of the camera is switched on or off. After starting the **HPD-TA** program, the cooler is switched off (default) and has to be switched on explicitly.

Attention!: Some camera versions require a vacuum pump and/or a water cooler for correct operation. Please ensure that the vacuum pump and/or water cooler is/are switched on and work correctly before you switch on the camera cooler. Otherwise the camera will not cool down to desired temperature and may even be damaged (if the protection circuit should fail).

The controls in the frame **Temperature** control the temperature of the CCD detector of the C4880 camera.

The **Actual** display box displays the actual temperature of the CCD whereas the **Target** edit box allows the user to specify the target temperature (from -110 to +50 °C in steps of 5 degrees). Please check your camera manual for the recommended operation temperature.

Camera Info

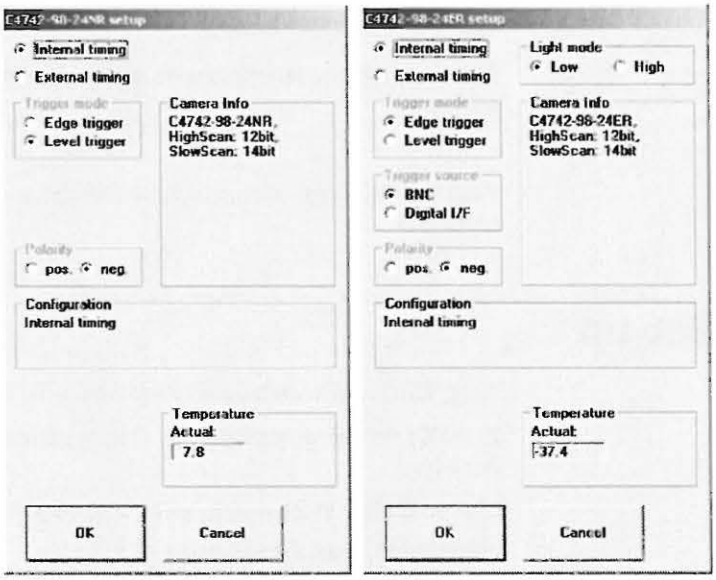
Inside of the frame **Camera Info** several camera features, as **ROM Version** (camera firmware version), **Chip** type and the settings of the potentiometers for contrast enhancement (**Vol. Offs.** and **Vol. gain**) are displayed.

C4742-98 Set-up

Note: This menu is only available if a C4742-98 (including the C4880-49, C4742-98ER and C4742-98BT versions) type camera is used!

In the C4742-98 set-up dialogue box several parameters of the C4742-98 camera can be set.

Choose **C4742-98** in the **Setup** menu to display the C4742-98 set-up dialogue box. Appearance of the dialogue differs slightly depending on the camera model.



C4742-98 camera set-up dialogue box (left), C4742-98ER camera set-up dialogue box (right)

Several basic settings of the C4742-98 can be selected here. The user normally wants to select these settings once and keep them for some time. Therefore these settings are stored and automatically used for your next session with **HPD-TA** .

Light mode

This is only available for C4742-985 ER camera models.
Two different settings of the camera can be selected. In Light mode **"Low"** the camera works with reduced sensitivity but maximum dynamic range, while in Light mode **"High"** the camera works with maximum sensitivity at a slightly lower dynamic range (please refer also to the camera manual).

Timing

If **Internal timing** is used the exposure time is controlled from the computer and the start of exposure from the C4742-98 camera, if **External timing** is used, exposure time and/or start of exposure is generated by an external trigger signal (please refer also to the camera manual).

If **External timing** is selected, two external trigger modes can be selected: **Edge** or **Level** triggering (please refer to the camera manual for a detailed description). In **Edge trigger** mode the start of an exposure is defined by an external trigger. The exposure time is defined by the program.

In **Level trigger** mode, start of an exposure and exposure time are defined by an external trigger signal.

Select **Trigger Polarity** in accordance to the electrical polarity of your trigger signal.

Shutter control

This is available for C4742-98 BT type cameras only.
If **Open** is selected the shutter will be always open. If **Close** is selected, the shutter will be always closed. If **Close on readout** is selected, the shutter will be automatically opened during exposure time.

Camera information

In this textbox the camera version and some important features of the camera are displayed.

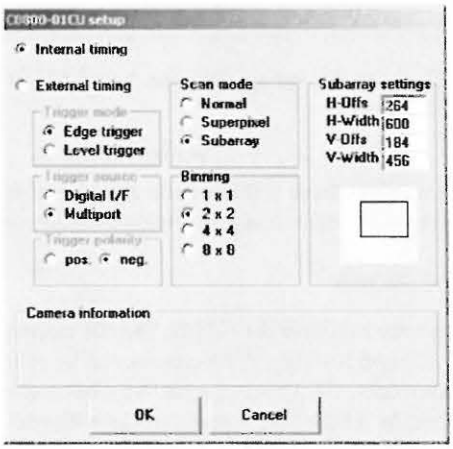
Press the **OK** button when you have finished your choice. Now the settings come into

C8800 Set-up

Note: This menu is only available if the C8800 camera is used.

In the C8800 set-up dialogue box several parameters of the C8800 camera can be set.

Choose **C8800** in the **Setup** menu to display the C8800 set-up dialogue box.



C8800 camera set-up dialogue box (subarray mode)

Several basic settings of the C8800 can be selected here. The user normally wants to select these settings once and keep them for some time. Therefore these settings are stored and automatically used for your next session with **HPD-TA** .

Binning

4 different formats can be selected.

Timing

If **Internal timing** is used the exposure time is controlled from the computer and the start of exposure from the camera, if **External timing** is used, exposure time and/or start of exposure is generated by an external trigger signal (please refer also to the camera manual).

If **External timing** is selected, two external trigger modes can be selected: **Edge** or **Level** triggering (please refer to the camera manual for a detailed description). In **Edge trigger** mode the start of an exposure is defined by an external trigger. The exposure time is defined by the program.

In **Level trigger** mode, start of an exposure and exposure time are defined by an external trigger signal.

Select **Trigger Polarity** in accordance to the electrical polarity of your trigger signal.

Camera information

In this textbox the camera version and some important features of the camera are displayed.

Scan Mode

Three different scan modes are selectable:

In Normal (1x1) the camera works at full resolution

In Superpixel mode the camera works with binning as selected in the Binning selection box

In Subarray mode the camera works with the binning setting selected in the binning box and the subarea selected as shown below.

Select the CCD area which shall be read out either by typing the desired values in the Subarray settings sections or draw a rectangle in the area below the Subarray settings section. Have the left mouse button pressed while you drag from the upper left corner to the lower right corner of the desired readout area.

Press the **OK** button when you have finished your choice. Now the settings come into effect.

Analog Camera Set-up (IC-PCI with AM-VS or PCVision only)

Note: This command is only available if you use a configuration with the PCVision or the IC-PCI board with the AM-VS input module attached in combination with an analog video camera.

This feature allows the user to set-up the analog video camera.

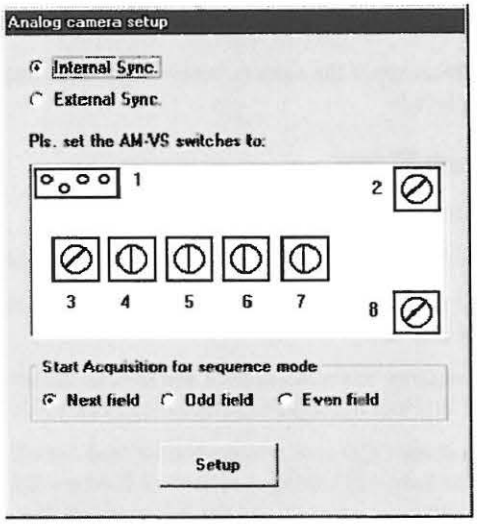
According to the type of camera used and according to some internal camera settings different drive methods for the cameras are supported. Please check your actual configuration before you make following settings. If you are not sure which setting is applicable, please consult your camera supplier.

If you choose **Analog camera** from the **Setup** menu the Analog camera set-up dialogue box will be opened.

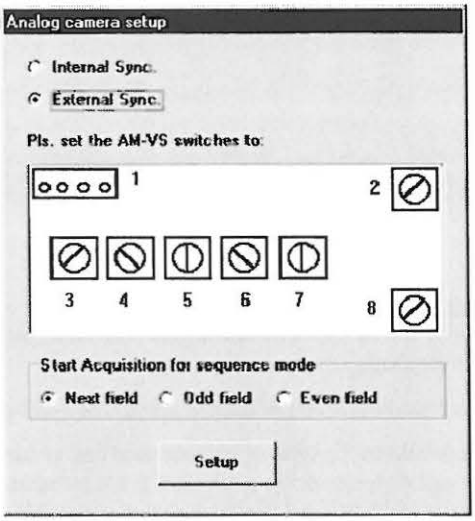
Attention: Do not remove the camera cable while your computer is switched on. Do not open the computer before you disconnected the power line.

You have to tell the program whether the camera runs with internal sync or should be driven externally.

For use with IC-PCI and AM-VS only: The program then tells you about the jumper settings on the AM-VS module. Please check whether they are correctly set on your frame grabber. Otherwise please modify them.



Analog camera set-up for internal sync



Analog camera set-up for external sync (C3077 or C5405 only).

The option **Start Acquisition for sequence mode** allows to choose, if grabbing of a sequence starts with the next field or with the next odd or even field (See also „Sequence“ on page129).

Scaling Set-up

***HPD-TA** allows to assign a scale to the horizontal and vertical axis of an image. In the scaling set-up the scaling information is assigned to the system, to the current image or to intensity profiles.*

First you can learn what scaling means in this program. Then you get an introduction to the different scaling methods (linear and table type) used in HPD-TA . In the section "System, Image and Profile Scaling" you learn about the hierarchical ordering of scaling. The following chapters show how to make the set-up of scaling for the different methods.

Introduction to Scaling

What is Scaling?

When acquiring images with a two-dimensional camera, light intensities are measured at certain detector elements. These elements are called pixels. Of course there is some spatial relationship (correspondence) between the pixels and the real world. The camera may look into a room with an ordinary objective lens, or it may look at some microscope image, or it may be used as a sensor behind a spectrograph or streak camera. In all cases there is a specific spatial correspondence between the image on the camera and the real world. Scaling is a way to get quantitative information about the real world by extracting data from the camera image.

The geometrical transformations made during scaling process may be simple or more complicated depending on the type of transformation the physical measure undergoes in the complete system.

The simplest (and most often used) way of scaling is to attach a single scaling factor to the system. The pixel distance from one point to the next is then just multiplied by that factor.

The most general way of scaling is to allow a totally free mathematical co-ordinate transformation function like:

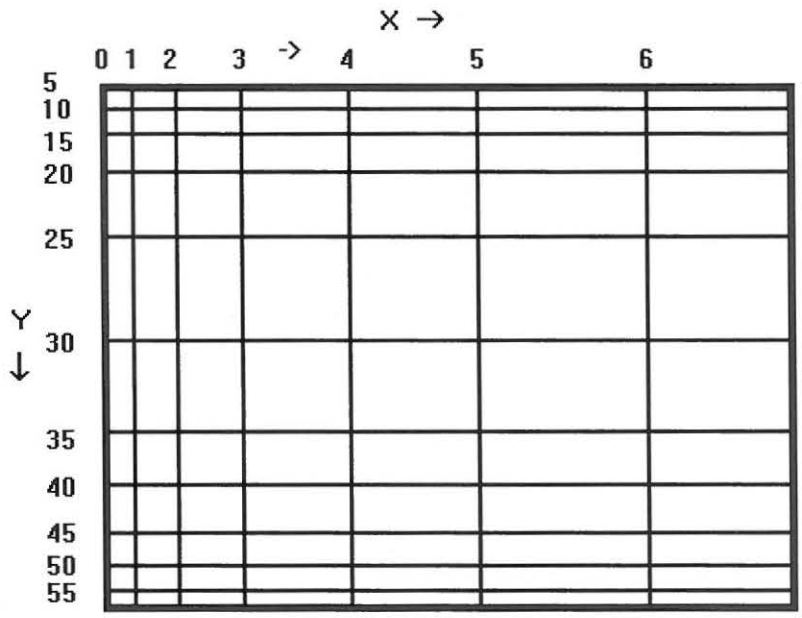
X_scaled =X_scaled (X_camera,Y_camera)

Y_scaled =Y_scaled (X_camera,Y_camera).

Such a very general scaling method, though it is the most versatile one, has three disadvantages:

- To perform such a scaling one would need two two-dimensional scaling arrays of the size of horizontal x vertical pixel number (x 4 byte at least).
- Lines with X_scaled =const or Y_scaled =const are no longer straight, making it very difficult to extract profiles along such lines (what the user typically wants to do).
- It is very complicated to handle this scaling scheme considering how the scaling data could be entered by the user.

Due to practical considerations a scaling scheme is implemented which is easy to use but versatile enough for most cases. This scaling scheme has the following possibilities and restrictions:



Example image of scaling (non-linear in X and Y direction)

- Lines with X_scaled =constant or Y_scaled =constant always have to be parallel to the camera axes.
- The scales in X and Y can be linear or non-linear. In the latter case they have to be monotonous (increasing or decreasing).

- Non-linear scaling is realised by function tables (called Table Scaling) and any functional relationship can be modelled freely by the user, as long as the "monotony condition" is met.
- Linear scaling in both dimension enables the user to measure data along any arbitrary direction (also non-parallel to the axes).

Linear and Table Scaling

The system scaling contains two sets of scaling data. One for the X axis and one for the Y axis. Each scaling axis can either be of linear or of table type.

The **linear scaling** consists of a scaling factor and a unit. When the unit is the same for both directions and the scaling is linear in both axes, the scaling information can be attached to profiles generated in any arbitrary direction (see "Scaling Method: Square Scaling" on page 68 and "Scaling Method: Free Scaling" on page 69). When the dimension is not the same in both directions or when table scaling is used at least for one axis, only horizontal or vertical profiles can be scaled.

When linear scaling is used the origin for the scaling data of intensity profiles is always the starting point of the profile. The scaling of a profile therefore looks always like:

Pixel No.	Scaling value
0	0
1	1 * Factor
2	2 * Factor
n...	n * Factor

Thus, the absolute value will depend on the location of the starting point. If normal images are analysed this is what the user typically wants. As a consequence, however, if you want to compare two profiles they should start at the same location. If you want to compensate an offset simply change the starting point.

The **table type scaling** consists of a table of **n** floating point values and a unit. **n** corresponds to the number of pixel in the axis. The **n** values reside in a scaling file with the extension **.scl** and are read automatically into memory when needed. The table may contain any values provided that they are strictly monotonous, either increasing or decreasing. (In other words, the function which the table resembles must be invertable.)

If you want to make non-linear scaling or attach absolute values to certain pixels or if you want to create scaling information which does not start at the value zero (e.g. for a spectrograph) you should use table scaling. Table scaling always yields the same scaled value at the same pixel location. Therefore absolute comparison is possible even if the profile windows do not start at the same location.

System, Image and Profile Scaling

The program distinguishes between the **system scaling**, the **image scaling**, and the scaling for every intensity **profile**.

System, image and all profiles individually can have different scaling information.

The scaling which is assigned to the system is always automatically applied to the current image at the moment the image is acquired. In case a profile is extracted from an image, the current image scaling is applied to the profile. The

system passes its scaling to the image, and the image passes its scaling to the profiles.

For this transmission mechanism the following situations may appear:

- The system scaling attaches information to the pixels on the chip (camera). If the image origins on chip and on frame-buffer are not the same, the system scaling must be shifted accordingly.
- If binning is active during image acquisition, the system scaling is modified accordingly. This means, internally a table will be compressed accordingly, and a scaling factor will be multiplied by the binning factor. All these mechanisms are fully automatic and do not require special care from the user.
- When a profile is extracted from the frame-buffer the valid image area is regarded and automatically checked whether the profile sampling window is contained in the valid image area. If not, the user will be prompted to modify the profile sampling window, extend the scaling data linearly or do not assign any scaling information to the profile.

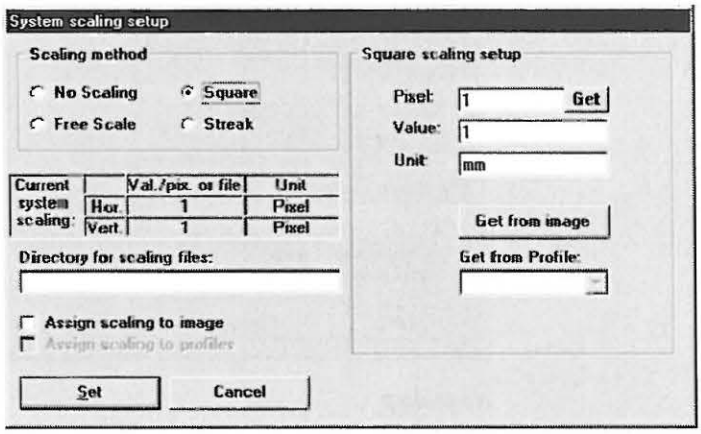
The scaling is always automatically attached to the images and profiles and re-activated when images and profiles are reloaded from disk. In most cases the system scaling can also be reconstructed from the information in the image or profile.

Scaling Set-up: Using Different Scaling Methods

The expression "scaling method" refers to the way how the system scaling is defined.

Choose **Scaling** from the **Setup** menu to display the Scaling set-up dialogue box.

There are several methods to tell the system which scaling it should apply for the X and Y axis.



Scaling set-up window

On the left side of the scaling dialogue box general information about the scaling method can be defined whereas the right side contains control elements to specify details about the scaling.

Scaling method offers several methods for scaling input:

No Scaling, Square Scaling, Free Scaling and **Streak.**

See "Scaling Method: No Scaling" on page 68,, "Scaling Method: Free Scaling" on page 69 and "Scaling Method: Streak Scaling" on.

Below the frame **Scaling method** the current system scaling parameter in horizontal and vertical direction are displayed. The scaling factors or the scaling file name and the unit are displayed.

The field below specifies the directory in which the scaling files reside.

When you set the system scaling you can select whether the scaling is also applied to the current image and/or to the profiles which may already exist. (**Note**: This is the only way how scaling information can be applied to images or profiles after they have been acquired.)

Assign the scaling data to the current image by clicking **Assign scaling to current image** and assign the scaling data to all existing profiles by clicking **Assign scaling to existing profiles**. Use this with care since this overrides any previously existing scaling information in these data sets. Normally these checkboxes should be off.

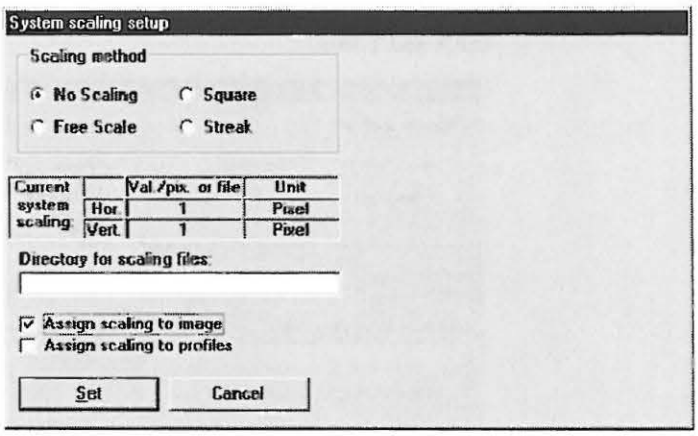
A typical case would be that you have taken an image and extracted a profile from this image and you now want to assign special scaling information to this profile. In this case the scaling information should be assigned to the current image and the profiles.

If you already have assigned valid values to the system, taken some images and some profiles, and if you then change something within your system (e.g. magnification), the scaling of the already existing data should not be changed, of course.

Therefore you can select whether you want to assign the scaling information to the image and the profiles or not. You can even display profiles with different scaling information in one display, provided that the unit is the same.

Scaling Method: No Scaling

When the program is started for the first time **No Scaling** is selected by default. **No scaling** is linear scaling with the factor 1 and the unit ""No unit" for the X and Y direction.

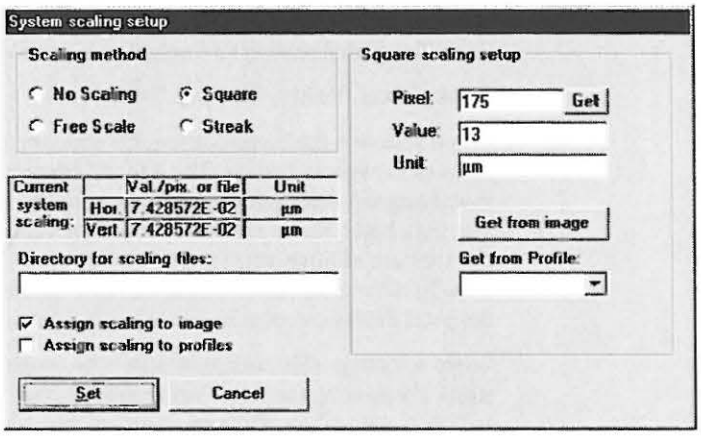


No scaling

Scaling Method: Square Scaling

Square Scaling is linear scaling with identical factors and units in both directions.

Select **Square** to enable the square scaling method.



Square scaling

Square size pixel are necessary to apply the square scaling method.

Square scaling is used in imaging applications when a camera with square pixels (like the Hamamatsu C4742-95, or the C4880-10 camera) is used. For setting of scaling one must input three values:

Pixel, Value, Unit.

The scaling is calculated in a way that the specified **Pixel** distance corresponds to the length **Value** with the unit **Unit**.

The **Pixel** distance can also be specified interactively by selecting a line ROI and pressing the **Get** button on the right side of the edit box **Pixel**. The distance in pixels is automatically calculated and inserted into the edit field.

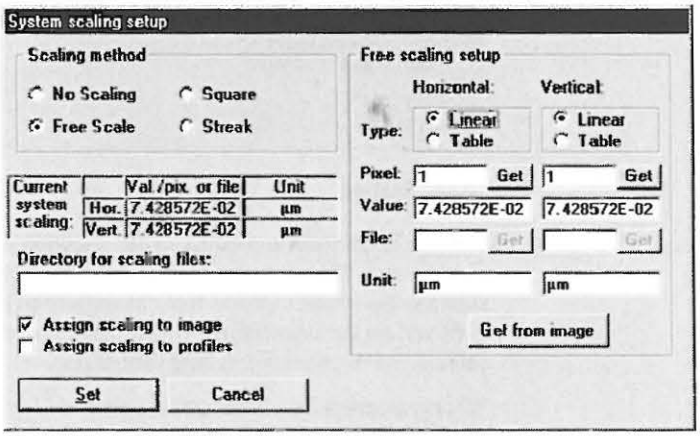
Under some circumstances the three values can also be transmitted from the current image or from a profile.

When clicking **Get From Image** the system scaling is passed from the scaling assigned to the current image. In this case, the scaling is transmitted from "bottom to top", in the opposite direction than the normal (automatic) transmission mechanism. The binning property of the image is taken into account to correctly derive the system scaling as it has been when the image was created.

Scaling Method: Free Scaling

Free scaling is a method of scaling where the user can select different scaling for the x and y direction.

Select **Free Scale** to enable the free scaling method.



Free scaling

The user can select the scaling type and the unit independently for both directions. For each direction five values can be specified:

Type, Pixel, Value, File and **Unit.**

When selecting the linear scaling, the meaning of **Pixel, Value** and **Unit** is the same as for square scaling. The only difference to square scaling is that you are specifying the scaling for each axis separately. Hence, for horizontal scaling you specify a horizontal pixel distance and for vertical scaling a vertical distance. For the ease of input you have to select a rectangular ROI (see "Rectangular Area ROI" on page 42) where either its width or its height are used to calculate the pixel distance depending on the axis direction.

When selecting table scaling **Value** is no longer valid, the entry **File** is valid instead. By pushing the small button **Get** on the right side of the **File** entry you can choose a scaling file from a file list. (See also the section "Scaling File Editor" on page 73 on how to create and edit scaling files).

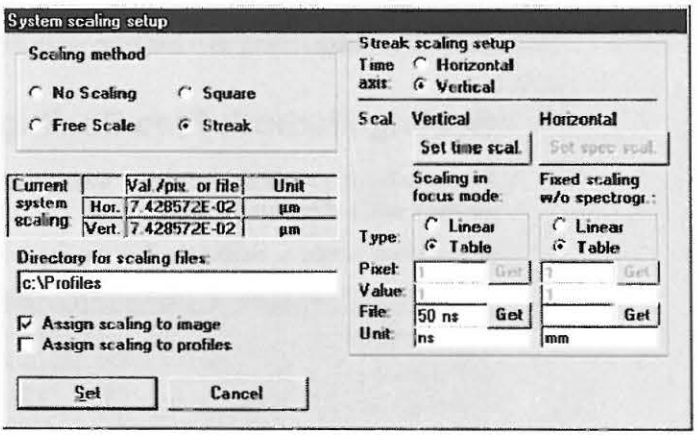
By pushing the button **Get From Image** the system scaling is transmitted from the scaling assigned to the current image. The binning property of the image is taken into account to correctly pass the system scaling as it has been when the image was created.

Scaling Method: Streak Scaling

***Attention**: In case of "streak scaling" the scaling is automatically switched when the time range of the streak camera is switched.*

Streak scaling is a special type of free scaling, where one axis is automatically scaled as time axis and two distinct sets of scaling values can be specified: one for the axis perpendicular to the time axis and one for the focus mode.

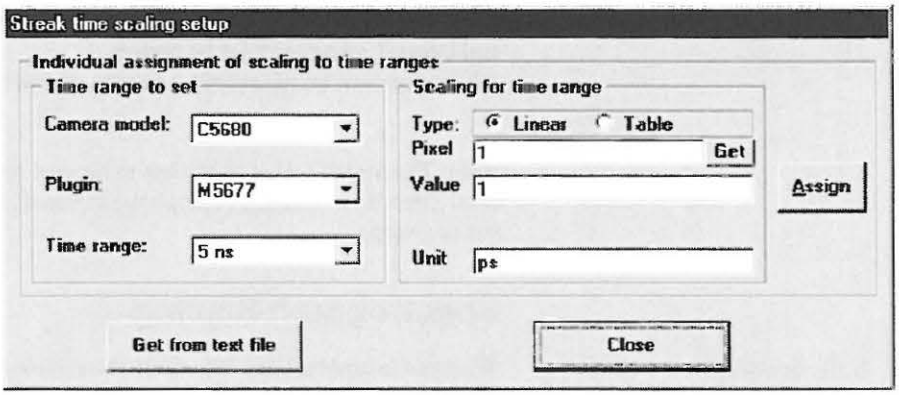
Select **Streak** to enable the streak scaling method.



Streak Scaling

Choose **Time axis** according to the direction of the streak sweep (time axis) of your system. This depends on the sweep direction of the streak camera (most Hamamatsu streak cameras have its deflection direction from the top to the bottom) and on the orientation of your readout camera (In most cases the readout camera can be mounted in both directions).

When you press **Set time scal.** a second display box **Streak time scaling setup** appears.



Streak Time scaling

Here you can specify one set of scaling data for each time range. You can attach scaling information to different time ranges of several sweep plug-ins and even several streak cameras. You can specify up to 100 such entries. These entries are automatically saved in the HPDTAr.INI file and loaded when the system is started again.

Select the time range to which you want to attach scaling information by selecting the correct entries from the three combo boxes **Camera model, Plugin** and **Time range** within the frame **Time range to set**. If there is already a valid scaling assignment you will see the values in the frame **Scaling for time range**. You can use this feature to easily check the correct scaling for every time range of your streak camera. Then enter the values within the frame **Scaling for time range** as described in detail in the section "Scaling Method: Free Scaling" on page 69. If everything is correct confirm the assignment by clicking **Assign Scaling**.

Note: You have to click **Assign Scaling** for each time range.

.

If you press **Get from text file** you can load the scaling data from a text file which may e.g. be provided with your streak camera. An example of a file is shown below:

```
480                                                  *1
C1587                                                *2
M1954                                                *3
1,ps,2,7.3077e-01, -5.0153e-05,7.7551e-08            *4
2,ps,2,1.2818e+00, -3.7142e-04,6.8962e-07
3,ps,2,2.4039e+00, -1.3683e-03,2.9215e-06
4,ps,2,3.9161e+00, -4.6214e-03,9.5888e-06
```

Notes to the streak time scaling files:

***1:** Number of valid Channels
***2:** Streak camera name (as it appears in the time scaling setup)
***3:** Plugin camera name (as it appears in the time scaling setup)
***4:** Scaling information for one timerange like:

```
2,ps,2,1.2818e+00, -3.7142e-04,6.8962e-07
| | |       |
*5*6 *7      *8
```

***5:** Timerange name (as it appears in the device status/control box)
***6:** Unit
***7:** Order of polynomial (n)
***8:** n Coefficients

Other notes:

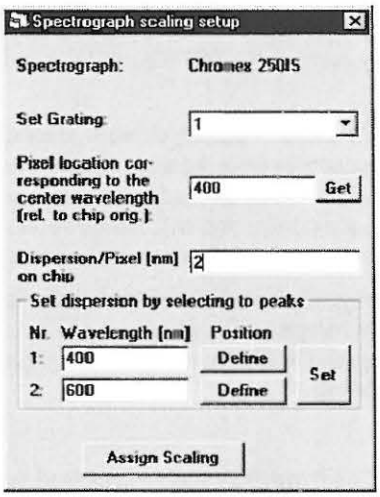
The spelling of all names (Streak camera, plugin, timeranges) must be precise and Upper/Lowercase must be correct
All entries must be separated by comma, the decimal delimiter must be a point.

Note: The Streak scaling setup has to be used when setting the time ranges for a Dual Time Base Extender, though the sweep direction is perpendicular to the streak sweep

Spectrograph Scaling

Note: Spectrograph scaling is automatically changed when the grating or centre wavelength of the spectrograph is changed.

When a spectrograph is used within the system (this means that you have clicked to the checkbox **"Use spectrograph"** within the device control Set-up (see "Device Control Options" on page 81), the push-button **Set spec. scal.** is enabled. When you click **Set spec. scal** the dialogue box **Spectrograph scaling setup** appears.



Spectrograph scaling window

The first line informs you about the name of the spectrograph used.

When making a scaling set-up for the spectrograph you first have to decide for which grating this set-up should be valid. Then you have to select a location (in the image) where the centre wavelength is located. Then you have to specify the dispersion per pixel. These values always refers to "location on chip". This means these values account for binning, subarray etc.

Please proceed as follows to make the set-up for spectrograph scaling:

- Use a light source of known wavelength.
- Set the centre wavelength of the spectrograph to this wavelength.
- Take an image (in any acquisition mode, may be Live mode) and you will see the corresponding peak somewhere on the screen (Due to slight misalignment it may happen that this peak is not exactly in the centre.).
- Move the cross-hair cursor in the image to the peak and press **Get** located on the right side of the entry **Pixel location corresponding to the center wavelength (rel. to chip orig.)**. The correct value will appear on the left side of this push-button.
- Select a centre wavelength on the spectrograph where you can see two known peaks.

- Enter the wavelengths of the two peaks in the text boxes **Wavelength** and point to the corresponding locations after pressing the two push-buttons **Define** for each peak.
- When this is done press the push-button **Set** and a value for **Dispersion/pixel [nm]** will be calculated and displayed in the corresponding text box.
- If all these values are correct press **Assign Scaling** to assign the scaling to the specified grating.

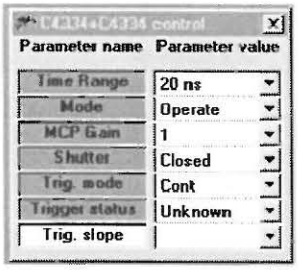
When the centre wavelength or the grating is now changed with the **status/control** box for the spectrograph the system scaling for the axis perpendicular to the streak axis is automatically updated. This scaling is linear with a fixed dispersion having the centre wavelength automatically at the location previously defined by **Pixel location corresponding to the center wavelength (rel. to chip orig.)**

Other Streak Scaling Set-up Items

On the system scaling window there are two other scaling items to specify: The first (left side) is for the same direction as the time axis but for focus mode (static mode), the second (right side) specifies the scaling in the axis perpendicular to the time axis. If vertical time axis is selected these two are (from left to right): **Vertical (Focus mode)** and **Horizontal**. If horizontal time axis is selected these two are (from left to right): **Horizontal (Focus mode)** and **Vertical.** The way of setting these items is same as described under "Scaling Method: Free Scaling" on page 69

When the time range in the **streak status/control** box (see "Status/Control (Streak Camera, Spectrograph, Delay)" on page 82) is changed (regardless whether it is changed manually or automatically) the correct scaling for the new time range is enabled automatically. The same is true if the mode changes from **Operate** to **Focus** or vice versa.

Also if the blanking amp is changed in a system with dual time base extender the scaling of this axis is changed automatically.



Streak status/control box

When the time axis scaling changes an informative message is displayed on bottom of the main window. There it is also displayed whether linear or table scaling is used, which streak camera plug-in model and which time range are selected and which factor or file and which unit are used.

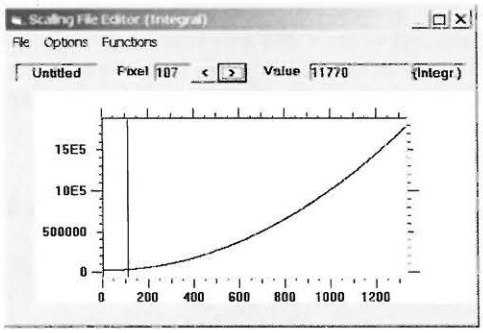
Scaling File Editor

The scaling file editor is used to create, view and edit scaling files (tables).

Scaling files are files which contain floating point entries (old type scaling files contain 1024 or 1280 entries) in either ascending or descending order. They must be strictly monotonous. They are used to assign scaling information to the system.

If you want to add new scaling tables, be sure to have the necessary data (polynomial coefficients) prepared.

Choose **Scaling File Editor** from the **Setup** menu to display the Scaling File Editor.



Scaling File Editor

It displays the values of the floating point numbers as a graphical curve. The display can be either integral of differential. If the display is integral the values themselves are displayed. If the display is differential the differences of neighbouring values are displayed. One can look at values by moving a cursor to a special location. The cursor can be stepped through all values by clicking **<** or **>**. Additionally the display shows the filename (if any), the pixel number of the actually displayed value, the value itself in numerical form, and an indication whether the display is integral or differential.

As soon as the scaling file editor is opened, the main menu of the program will be replaced by the scaling file editor menu. It includes following commands.:

Menu	Command	Function
File	Load Scaling File	Loads a scaling file into the memory and displays it.
	Save Scaling File	Saves the current set of data to a scaling file on disk.
	Exit	Closes the editor.
Options	Integral Display	Display curve in integral mode.
	Differential Display	Display curve in differential mode.
Functions	Create Diff. Polynomial	Opens a dialogue box where a set of scaling data starting from a differential polynomial can be calculated.
	Create Integr. Polynomial	Opens a dialogue box where a set of scaling data starting from an integral polynomial can be calculated.
	Multiply with value	Multiplies the polynomial with a value.
	Add value	Adds a value to the polynomial.
	Print	Print scaling file data.

Load Scaling File loads a scaling file into memory and displays it. This function automatically checks whether the specified file is a valid scaling file or not.

Save Scaling File saves the current set of data to a scaling file on disk. It is only enabled when valid scaling data are defined.

Exit closes the **Scaling File Editor** window.

Integral Display switches to integral display mode.

Differential Display switches to differential display mode.

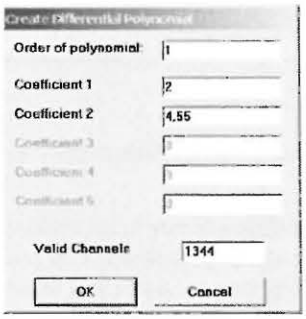
Create Diff. Polynomial allows to calculate a set of scaling data starting from a polynomial specifying the differences of data values.

$Diff = A0 + A1*i + A2*i^2 + ...$

A0: Coefficient 0
A1: Coefficient 1 etc.
An: Coefficient n (if the order of the polynomial is n)

A dialogue box **Create Differential Polynomial** is opened, if you choose **Create Diff. Polynomial** from the Functions menu.

To create a polynomial select the order of polynomial first. Then insert the coefficients. Finally press **OK** to confirm the data input.



Create differential polynomial

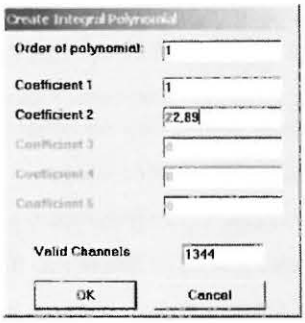
Create Integr. Polynomial allows to calculate a set of scaling data starting from a polynomial specifying the data values.

$$Value = \sum_{0}^{x} A0 + A1 \times i + A2 \times i^2 + ...$$

A0: Coefficient 0
A1: Coefficient 1 etc.
An: Coefficient n (if the order of the polynomial is n)

A dialogue box **Create Integral Polynomial** is opened, if you choose **Create Integr. Polynomial** from the Functions menu.

To create a polynomial select the order of polynomial first. Then insert the coefficients. Finally press **OK** to confirm the data input.



Create integral polynomial

The maximum polynomial order allowed is five for the integral and the differential polynomials.

Take care not to accidentally overwrite these factory calibration data, otherwise you will need to input them again.

The time range coefficients which are predefined and delivered by the Hamamatsu factory together with the streak camera are differential coefficients. Be sure to use the correct method if you want to input these coefficients by yourself. (However, normally this was already done by Hamamatsu before delivery).

Trigger setup

Select **Trigger setup** from the **Setup** menu to display the Trigger setup dialogue box.

The **Trigger setup** dialog allows to select the most suitable trigger configuration for your application and hardware. You can choose among 3 trigger methods. The Trigger setup dialogue helps you to check proper hardware settings and software settings. Please refer also to " Appendix K: Typical hardware configurations".

During start of the program you have selected the basic hardware configuration of your system, as camera and frame grabber, streak camera type and configuration as well as hardware for triggering.

In this setup details of triggering can be set up.

Please be sure that you have chosen the proper hardware setup before you start Trigger setup. Whenever possible HPD-TA will try to confirm proper settings automatically. The Trigger setup settings are automatically saved and restored.

Basically HPD-TA offers three different types of trigger methods:

Not synchronized

The streak camera operates in synchroscan mode or in continuous single shot mode. The readout camera runs asynchronous to the streak camera with the parameters as defined in the acquisition dialog.

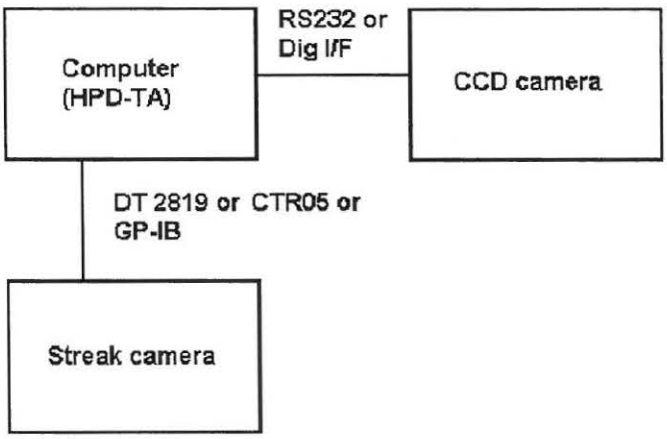
Enclosing method

The CCD camera is started and stopped by computer control. After start of an exposure the trigger handshake starts. When all triggers have been processed the CCD camera exposure is ended by computer control and the resulting image is read out. This method is called „Enclosing method" since all actions related to streak triggering happen during the exposure time of the CCD camera.

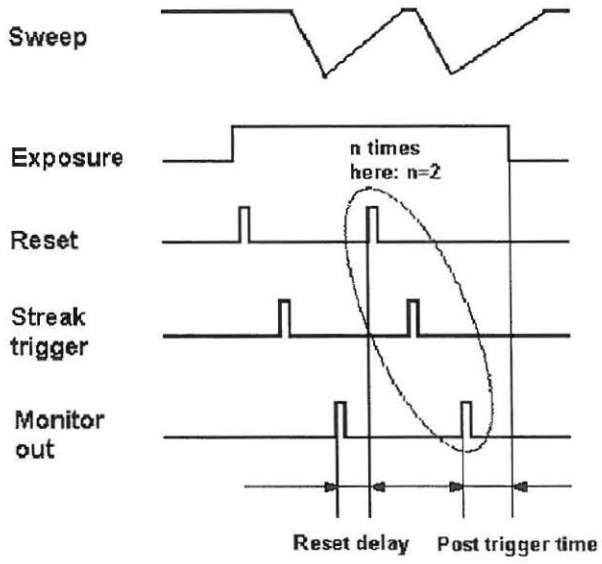
Sequential method

Streak trigger and CCD camera exposure is done one after the other. The monitor out signal of the streak camera triggers the start of the exposure. The exposure time is defined by the user and fixed for all trigger events. This method is called sequential method because streak triggering and CCD exposure is done sequentially.

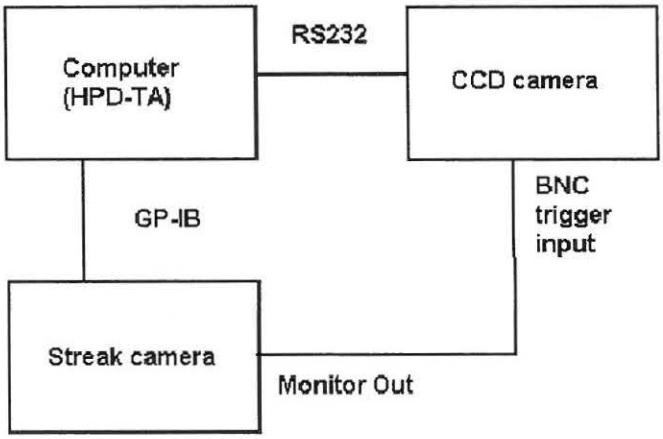
Following are the main differences between Enclosing and Sequential method:



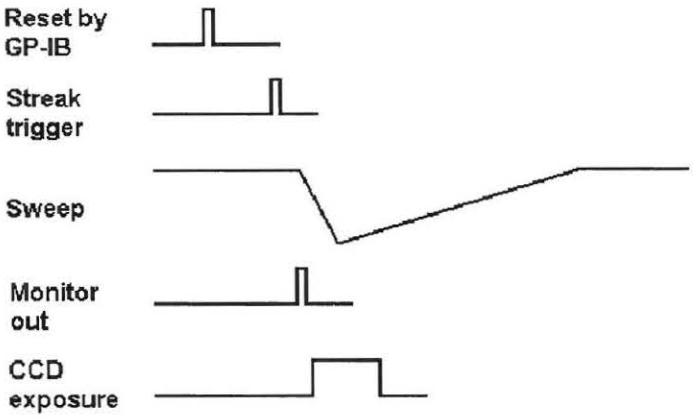
Hardware setup for enclosing trigger method. No direct electrical interface between streak camera and CCD camera is used.



Timing diagram for enclosing method.



Hardware setup for sequential trigger method. A direct electrical interface between Streak camera and CCD camera is used.



Timing diagram for sequential method.

Topic	Enclosing trigger method	Sequential trigger method
Speed	Several Hz for GP-IB, high frequency for DT2819 or CTR05 (many kHz)	One shot per one CCD frame
Multiple shots	Many shots per CCD frame	One shot per one CCD frame
Requirement to "monitor out" signal of streak camera	Requires "monitor out" after sweep. If "monitor out" is before sweep this can be compensated by post trigger time	Requires "monitor out" before sweep (Mandatory).
Exposure time	Exposure time is always defined correctly to contain the pulse (Because both start and stop of CCD camera is synchronized to streak trigger). Requires the ability to stop CCD camera exposure (Sometimes CCD camera does not have this ability, e.g. C4880-8X)	Exposure time must be defined correctly. Monitor out must be sufficiently long time before sweep (depends on CCD camera reaction time).
Dark current	Dark current varies with exposure time. (If repetition rate is very low and non-constant, this may be a problem)	Exposure time is constant
Additional advantages		Streak cameras without GPIB do not require additional hardware. Special CCD cameras can be used (like C4880-8X)

Comparison of the two trigger methods

How to make trigger setup

1.Select the desired trigger method in the trigger setup dialog. The dialog will change according to the selection you have made.

2. The "Streak trigger setup" dialog shows the required connections blinking in red. Once the user has established the connection he should confirm these in a checkbox located nearby the blinking line. When all necessary connections are done properly and confirmed the "Streak trigger setup" dialog shows "Configuration valid" with green background. (Sometimes there are optional connections which can be done to speed up operation. These are indicated with blinking white connection lines.)

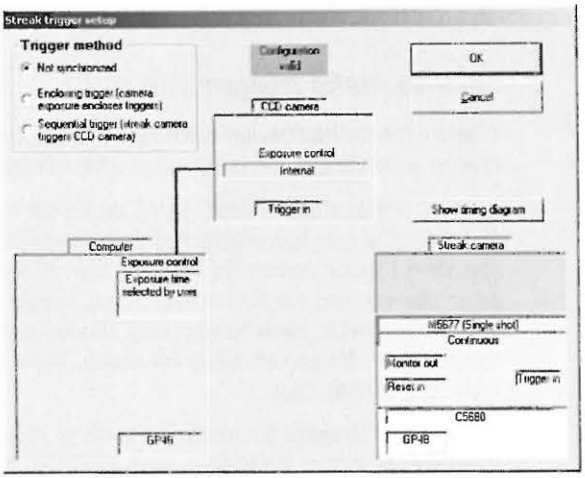
The user has to make the necessary settings in the streak camera control window if the streak camera is not connected by GPIB. In the case the streak camera is connected by GPIB the necessary settings are set when the "Streak trigger setup" dialog is quit by the OK pushbutton (of course they can be changed afterwards, so be careful not to change any parameters which are essential to the trigger operation) or when the user switches between Operate or Focus mode or time ranges of the "Blanking amp." Parameter (which defines the horizontal sweep of a dual time base extender).

3. Depending on the trigger mode the streak trigger checkbox on the camera acquisition dialog is enabled or disabled (It is enabled when the streak trigger method is enclosing or sequential, disabled in non-synchronized mode).

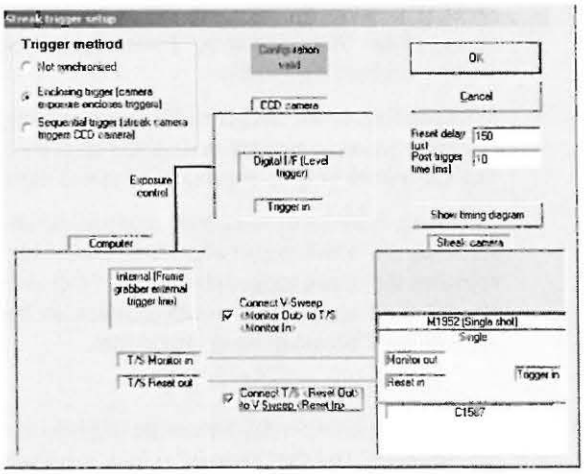
Switching from focus to operate mode in the streak cameras status/control box activates the streak trigger checkbox. Switching from operate to focus mode deactivates the streak trigger checkbox. If a dual time base extender is used the streak trigger checkbox is switched when the horizontal sweep is switched on or off with the "Blanking Amp" parameter.

The value entered for the **Reset delay (µs)** specifies the delay between the "monitor out" and the "reset in" pulses in microseconds when working with external triggers. The default setting of 1500 microseconds should work for all Hamamatsu streak cameras. The value can be decreased in some cases in order to achieve higher repetition rates (contact Hamamatsu for details on specific streak cameras). The minimum value is 1.

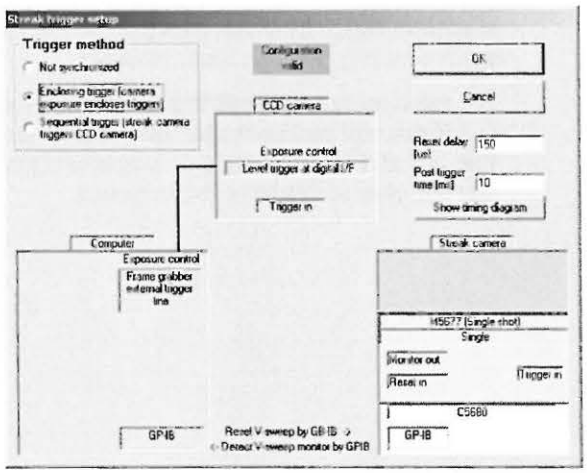
The value entered for **Post trig. time (ms)** specifies the time, for which the acquisition still continues after the specified number of triggers are counted. This is useful for very long time ranges or if some afterglow of the streak cameras phosphor screen has to be integrated.



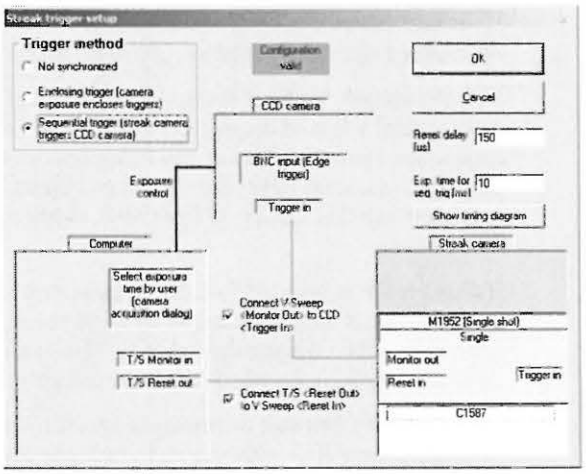
Trigger setup dialog *Not synchronized* method



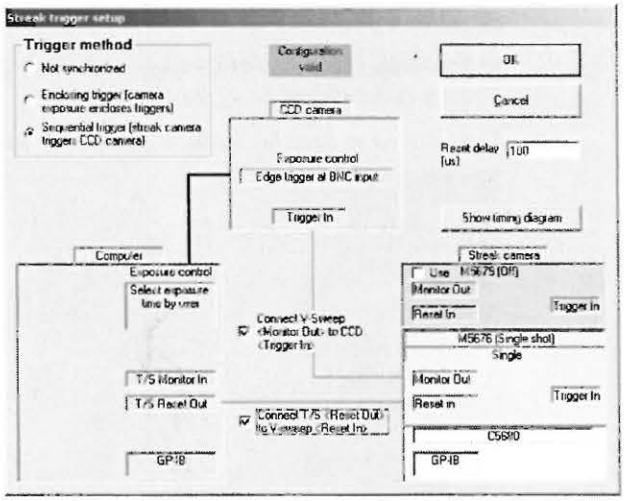
Trigger setup dialog *Enclosing method*, without GPIB control



Trigger setup dialog *Enclosing method*, with GPIB control



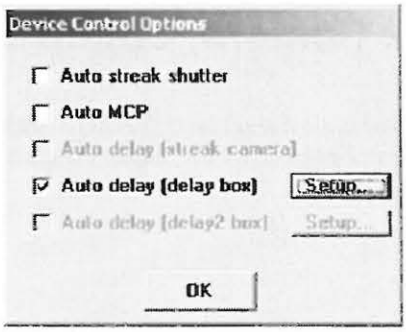
Trigger setup dialog *Sequential method*, without GPIB control



Trigger setup dialog *Sequential method*, with GPIB control

Device Control Options

Select **Device Control Options** from the **Setup** menu to display the **Device Control Options** dialogue box. There are five items which can be selected, the **Auto streak shutter, Auto MCP, Auto delay (streak camera), Auto delay (delay box)** and **Auto delay (delay2 box)**.



Device Control Options Dialogue box

If the parameters can be controlled by GPIB (e.g. for the C5680) these options are enabled and can be selected (see also "Starting the program" on page20).

If **Auto streak shutter** is selected the streak shutter will be always automatically opened when an acquisition is started and automatically closed when the acquisition ends. This feature can be used to prevent the streak camera of being exposed to incident light when no measurement is under progress. We strongly suggest to use this feature, if applicable, to help avoiding accidental damage or tube burn-in.

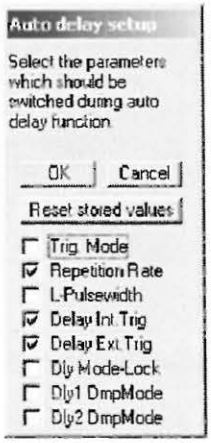
If **Auto MCP** is selected the MCP gain as previously set by the user will automatically be set when an acquisition is started and automatically set to the minimum value when the acquisition ends. This is also a function which helps to protect the streak tube when no measurement is under process.

If **Auto delay (streak camera)** is selected, the "delay"parameter in the streak camera s control box will be saved when you change the time range and restored when the time range is used the next time.

If **Auto delay (delay box)** is selected, the current settings of a delay unit will be automatically saved when you change the streak camera time range. These parameters will be set again, when you return to this time range later.

Auto delay (delay2 box) works like **Auto delay (delay box)** but for the settings of the second delay unit.

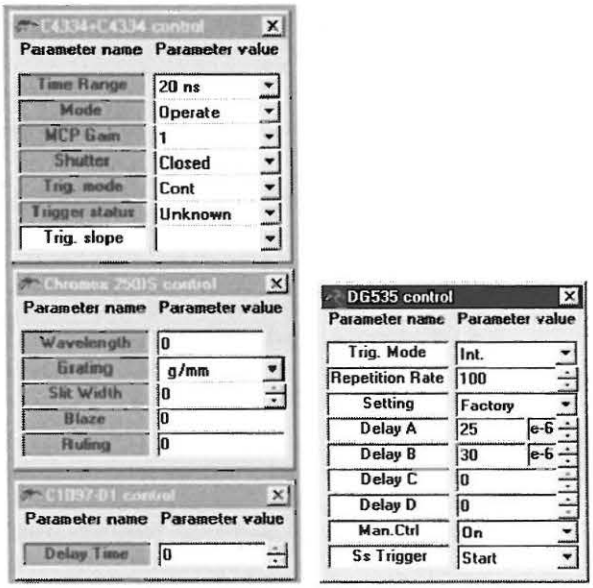
Press **Setup** to open the **Auto delay setup** dialog.



Select the parameters which shall be saved and restored. Press **OK** to save the setting. Press **Restore stored values** to reset all stored values to the currently selected values.

Status/Control (Streak Camera, Spectrograph, Delay)

After the device control set-up is finished a ***Status/Control box*** *will be built for each device present. In this chapter common characteristics of such control boxes are described.*



Device Status/control boxes (Streak camera C 4334, Spectrograph 250S, DG 535 and delay unit C 1097)

According to the information given in the set-up the system determines whether the device can be externally controlled, whether status information output is available, and which selectable parameters exist for this device and which values they can have.

If a parameter can be controlled by the HPD-TA, the background of the parameter name (left side of the status/control box) is green. If only status output is available, the background is red. If no control and no status are available the background is white, and if control but no status output is available the colour is yellow.

Colour	Remote control	Status read
Green	yes	yes
Red	no	yes
White	no	no
Yellow	yes	no

Colour coding of Status/Control boxes

Parameters may be displayed in exponential form a x 10^{y}. a is then displayed on the left side of the parameter field an the exponent y is displayed on the right side.

There are different types of parameters and the corresponding controls are different:

Some parameters can have a list of different valid values (e.g. Mode can only be **Operate** or **Focus**). The selection is done with a combo box.

Other parameters can have integer values (e.g. MCP gain). You select the value with a text box and two small arrows to increase or decrease the value (so called "spin-control").

Other parameters can have floating point values (e.g. gate time). These can be selected by inputting numbers in a text box. In special case (when the virtual device has a special knowledge about the step-width of allowable values) addition-

ally two small arrows appear to increase and decrease the value (so called "spin-control").

If only status output is available for a parameter (if the user cannot modify this parameter) then its value is displayed in a display box, and there will be no control element for it.

In this case, the parameter must be changed at the device manually, and the **HPD-TA** will sense the change through the status input and reflect it correctly in the display box.

Switching from focus to operate mode within the streak cameras status/control box activates the streak trigger checkbox in the image acquisition menu (see also "Acquisition Menu" from page 94). Switching from operate to focus mode deactivates the streak trigger checkbox

If no control and no status output is available, you will need to control the device manually but the **HPD-TA** cannot sense any status changes automatically. In this case, you should change the parameter in the Status/Control box explicit and manually as well, so that the programs internal status reflects the status of the device correctly. This is very important for the correct handling of image status information, scaling data, and so forth.

In case a distinct step width between allowable parameter values is known (integer type parameters and special real type parameters) one can use the arrow up (↑) and arrow down (↓) cursor keys to increase and decrease the value as well as the spin control. If you additionally press Shift, Control or Alt key the step width depends of the number of such keys. If a single key is pressed (either Shift, Control or Alt) the step width is increased 10 times. If two such keys are pressed (either Shift and Control or Shift and Alt or Control and Alt) the step with is increased 100 times. If all three keys are press (Shift, Control and Alt) the step with is increased 1000 times. This is true both for the spin control and the arrow keys.

Sometimes it may be preferred to edit the numbers in exponential notation, especially if the numbers are very small or very large.

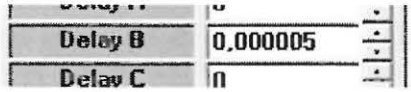
Enter the parameter field where you want to edit an exponential number and type "e". A dialog appears where you have to input the value of the exponent.

Then press OK.

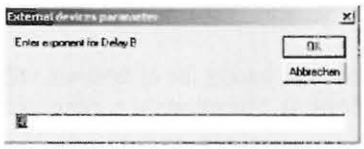
The display will now change in the control table. The mantissa and the exponent of the number are displayed.

Now the spin up/down buttons are used to change the value of the mantissa only

Example: Exponential notation of Delay B value:



... before



after typing "e" the input dialog for the exponent appears.

After pressing OK the value is displayed in exponential notation.

Emergency!

Emergency! is a function to protect your streak camera from any damage if too much light enters the camera by some accident.

Select **Emergency!** in the Setup menu or press the function key F8, to set the MCP gain of your streak camera to the minimum value and to close the streak camera shutter and/or the shutter of the spectrograph immediately.

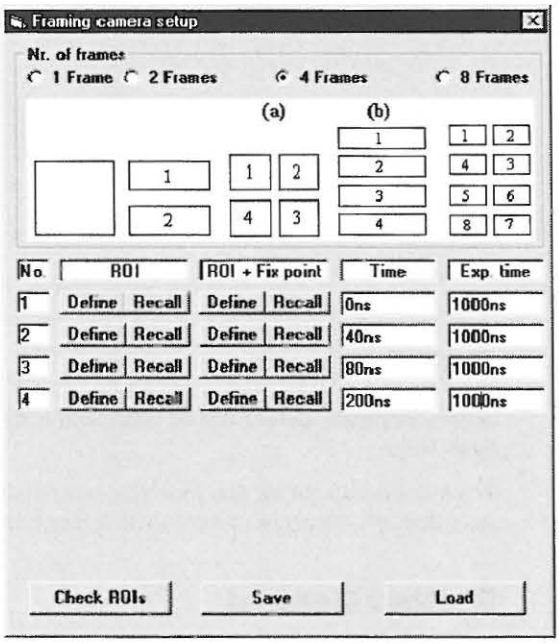
Of course this can only work if the respective devices can be controlled by GPIB.

Framing Camera

This is a function to make the set-up for processing of images acquired with a framing camera. An image obtained from a framing camera consists of several frames (sub-images). In the set-up menu you can define these frames. Later you can use the ***Framing > Sequence*** *command from the* ***Processing*** *menu* (see "Framing>Sequence" on page 179) *to separate a framing image into frames and convert it into an sequence of images.*

Choose **Framing Setup** from the Setup menu to open the Framing camera set-up dialogue box. Then follow the procedure described below to make the set-up:

1. The Hamamatsu framing camera offers an output image, which consists of several frames. In the framing camera set-up dialogue box, you can specify, which type of frame arrangement you want to use (please choose the same setting as on your framing camera). Select the arrangement in the frame **Nr. of frames**.



Framing camera set-up dialogue box

2. Acquire an image with the framing camera and display it on the monitor.
3. Set an area of interest for each of the frames. This will be used later as the frame border when a framing image is converted to a image sequence.

   To do this, select the area ROI tool first. Draw an ROI around the first frame of your framing image. Then press the button **Define** of the frame no.1 in the dialogue box column "**ROI**". Also you should note the time and exposure time of this frame in the related text boxes.
   Repeat the same for the other frames. Use the same ROI and just move it to the next frame by using the Move and Resize ROI tool.


Area ROI tool
Note: All ROIs have to have the same size. Otherwise the image can not be converted to a sequence later.


Move and Resize a ROI

4. *This is an alternative method to step 3:* If you want to be sure that a certain point of your frames is always at the same point in a sequence, you can use also the **Define** button of the "ROI + Fix point" column.
   Proceed as follows: Draw the first frame using the area ROI tool. Then press **Define** in the first raw of the column "ROI". Change to the point ROI tool and select a point which shall be the fix point within the first frame. Press **Define** in the first raw of the column "ROI+Fix point". Select the fixpoint in the second frame and press **Define** in the second raw of the column "ROI+Fix point". Do this for all other frames. The ROI (size) which you have chosen at first will be used for all frames. The frames will be set always in the same relative position to the fix point as defined for the first frame.
   Note: If a fixpoint is chosen so, that the surrounding ROI exceeds the image borders, the image sequence cannot be generated later on.

You can recall each ROI by clicking at the related **Recall** buttons.

To display all selected ROIs at once, press **Check ROIs**. If there is an incorrect setting, a warning message will be displayed.

To save a set-up, press **Save.** Then a dialogue box will be opened, where you can select the desired file name and directory.

You can load a set-up which was saved earlier by clicking **Load**.

Note: The settings made in the C 4187 framing camera control are automatically transferred to the Framing camera set-up.

Options

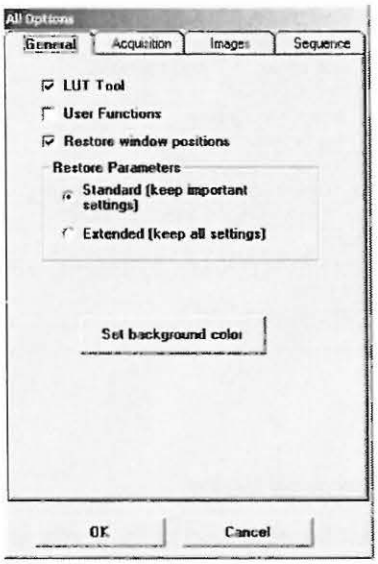
Overview

*Several program options can be controlled with the commands listed in the **Options** menu.*

The dialogue is split up into four tab control sections: The section **General, Acquisition, Images** and the section **Sequence**.

Section General

In this section some settings for the preferences of several commands can be set. Choose the tab General to display following dialogue:



Dialogue Options, General

LUT Tool

☐ *The LUT tool*

When the **LUT tool** option is checked the LUT tool is visible (default) after starting the program.

User Functions

When the **UserFunctions** option is checked, function calls to a DLL named CUSTOMER.DLL are enabled. With this option the user can implement his own control and data analysis functions into (see also chapter " User Function" on page 176.

Restore Window Positions

Standard: If this option is checked, the program stores the position and size of every window when it is closed. The settings will be restored, when the window is opened for the next time.

Restore Parameters

Here you select if all current settings are saved when you close the program or if only a part of the parameters will be saved. The saved parameters will be re-called when you start the program for the next session.

Standard: If this option is checked, the program stores the basic program settings.

Extended: Additional parameters are saved:

Acquisition Options: "Auto backsub"
Acquisition Options: "Auto shading"
All camera acquisition dialogs: All parameters (except photoncounting method and threshold)
All camera setup dialogs: "Trigger mode"
C4880 Setup: Gain/Offset
C4880 Subarray Dialog: All settings
C7300 Setup: Subarray Offset/Width
General Options: "LUT Tool"
Images Options: "Get Histogram for Auto LUT in ROI only"
LUT parameters: Gamma value
LUT parameters: LUT type

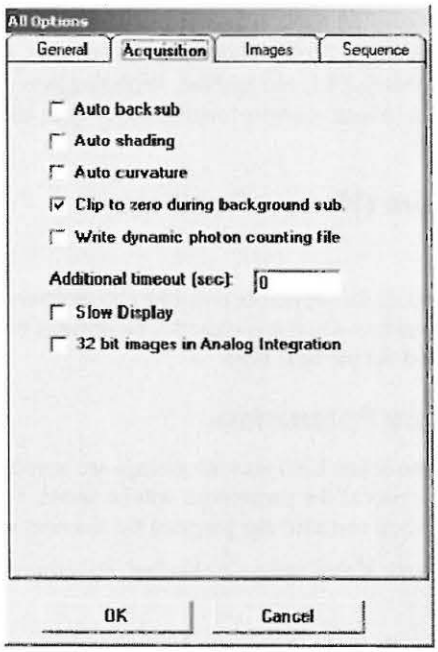
Sequence mode, acquisition: "Acquire ROI"
Sequence mode, acquisition: "Acquisition mode"
Sequence mode, acquisition: "Full speed" / "Fixed intervals"
Sequence mode, acquisition: "No. of Loops"
Sequence mode, acquisition: "Wrap" during play
Sequence mode, acquisition: Play "Interval"
Sequence mode, acquisition: ROI for "Acquire ROI"
Sequence mode, data storage: "Acquire and store defined profiles"
Sequence mode, data storage: "Store to HD" / "Store to RAM"
Sequence Options: "Wrap around"
Toolbar: ROI Tool (Pointer, Zoom, Point ROI, Line ROI, Area ROI, Modify ROI)
Toolbar: Show Profile Windows (Icon)
Toolbar: Show Quick profile (Icon showing "PRF")
Toolbar: Show ROI I/F (Icon)

Set background color

If you click **Set background color** a color selection window will be displayed where you can choose the background color of the program main window.

Section Acquisition

Choose the tab **Acquisition** from the **Options** menu to display the Acquisition options dialogue.



Acquisition and display options dialogue

Auto Backsub

When the **Auto Backsub** option is checked, background subtraction is automatically performed after an image acquisition. Please refer to "Background Subtraction" on page 152 and "Background Subtraction" on page 147 for details about Background subtraction.

Auto Shading

When the **Auto Shading** option is checked, shading correction is automatically performed after an image acquisition. This menu item can only be enabled if **Auto backsub** is enabled. Please refer to "Shading Correction" on page 154 and "Shading Correction" on page 147 for details about Shading correction.

Auto Curvature

When the **Auto Curvature** option is checked, curvature correction is automatically performed after an image acquisition. Please refer to "Curvature Correction Set-up" on page 157 and "Curvature Correction" on page 148.

Clip to zero during background sub.

If this command is selected, negative intensity data are clipped to zero. Negative intensity data may appear after background subtraction.

Write dynamic photon counting file

If **Write dynamic photon counting file** is selected, the recording of photon counting images in the special DPC file format is enabled. In a DPC files the x-y co-ordinates of each photon and the time when it has been detected are recorded. This allows to make a time dependent analysis of photon counting images (see "Dynamic Photon Counting (time resolved 2-D photon counting)" on page 99).

Additional timeout

The parameter **Additional timeout (sec)** can be used to define an additional timeout, after which an image acquisition will be stopped, if no response comes from the camera.
Usually this time should be 0. Only in some special case when you get timeout errors before an image acquisition has been finished, you may increase this parameter. Normally the timeout is automatically calculated:
Timeout = System defined timeout (derived from the exposure time) + Additional timeout (sec).

Slow Display

This function reduces image display speed. It should not be selected unless it is evident that your computer has problems with image display speed.

32bit images in Analog Integration

If this parameter is checked, the image files of all images acquired in Analog Integration mode (see e.g. „Analog Integration Mode" on page 103) will have 32 bit depth. If it is not checked, the files will be 32 bit files only if the camera has 16 bit data output.

Defect pixel correction

If this parameter is checked the defect pixel correction function will be applied for all images which are acquired newly.

Select the pixel correction map file which fits to your sensor in the **File** field. (for generation of a pixel correction file please refer to "Corrections" on page 147).

Section Images

Choose the tab **Images** from the **Options** menu to display the Images options dialogue.

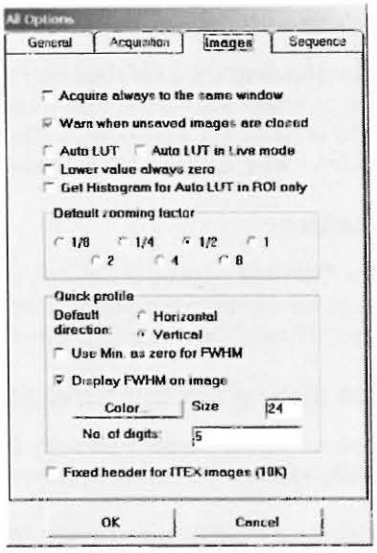


Image options dialogue

Acquire always to the same window

When the option **Acquire always to the same window** is selected the **Acquire** and **Analog Integration** functions always use the same image window for acquisition. This is useful to avoid that the PC memory is quickly used up for storage of images. The default behaviour concerning new images is as follows: The Live mode always acquires to the same window. The image load function opens always a new image. The Acquire and Analog Integration function opens up a new window every time they are invoked.

Warn when unsaved images are closed

When a window is closed and the image is not or not fully saved the program issues a warning prior to closing the window (default). When the checkbox is not selected the program does not issue such a warning.

Auto LUT

When the **Auto LUT** option is checked the LUT is adapted automatically during image acquisition (e.g. during analog integration and photon counting), after acquisition, background subtraction and loading an image (see also "LUT Tool" on page 36).

Auto LUT in Live Mode

When this option is checked the image contrast will be updated by the AUTO LUT function whenever a new image is displayed in Live mode.

Lower values always zero

When this option is checked the lower limit of the LUT will always be set to 0 when automatic LUT calculation is executed (e.g. by pressing the „*“ button of the LUT tool or by using AUTO LUT mode). If the option is unchecked the lower value will be calculated.

Get Histogram for Auto LUT in ROI only

When this option is checked the Auto LUT function will optimize the image contrast for grey values which are within the boundaries of the actual ROI. This allows to optimize the contrast based on the grey levels within a limited image

area. Please refer to the section „Rectangular Area ROI“ on page 42 for how to set a ROI. If no ROI is selected, the whole image area will be considered as actual ROI. This function will be only active if Auto LUT is enabled.

Default zooming factor

When a new window is opened a default zooming factor is used for the display. The radio buttons within the frame **Default zooming factor** is used to define the default zooming factor.

Quick profile

In the frame **QuickProfile** several default parameters of the QuickProfile function can be set (see also "QuickProfile." on page 43).

You can select the **Default direction** of intensity analysis by choosing either the **Horizontal** or **Vertical** button. You can change this setting also later on at an actual profile by changing the direction in the ROI info window. (see "Display ROI data" on page 43)

Select **Use Min. as zero for FWHM** in order to calculate the FWHM data relative to the minimum intensity value of the profile. If it is not selected, the FWHM value will be calculated relative to the intensity value 0.

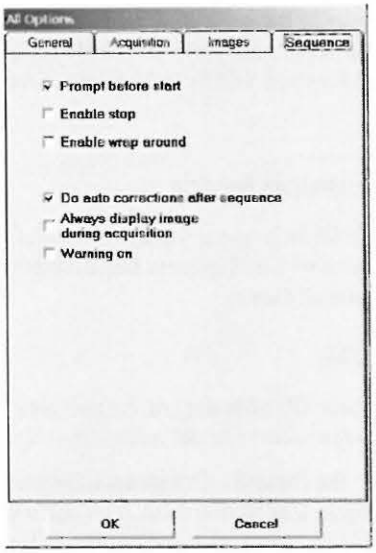
Select **Display FWHM on image** if the FWHM value shall be displayed on the image. If this is selected the **color** and **size** of the FWHM digits can be selected as well as the number of digits **No. of digits.**

Fixed header for ITEX images

The image status information is stored in a string in the image file header. Normally the length of this string varies with its content. However, in some cases it is desired that the header has a fixed length. If this option is checked the length of the header is always 10K.

Section Sequence

Choose the tab **Sequence** from the **Options** menu to display the Sequence options dialogue. This dialogue will can also be opened from the Sequence dialogue (see "Sequence" on page 129).



Sequence options dialogue

In the frame **Sequence** several default parameters of the sequence acquisition mode can be selected.

Prompt before start

Normally a sequence acquisition is not started immediately after you click **Start Acquisition** in the sequence acquisition dialogue (see "Sequence" on page 129). Before the acquisition actually starts, an initialisation procedure is executed. If **Prompt before start** is selected, the system will display a message box after the initialisation is completed. Sequence acquisition will be started immediately after you click OK in this message box. This is useful if you want to precisely control the starting time of sequence acquisition.

Enable stop

If **Enable stop** is selected, it will be possible to stop sequence acquisition at any time. If it is not selected, sequence acquisition can be stopped only by the user function (see "User Function" on page 176). Of course sequence acquisition will stop latest when the pre-selected number of images has been acquired. If **Enable stop** is selected, the sequence acquisition may be slightly slower on older computer.

Enable wrap around

If **Enable wrap around** is selected, the sequence function will allow to acquire a sequence in the wrap around mode (see "Sequence" on page 129). This function is only available, when the **Enable stop** is selected.

Do auto corrections after sequence

If the checkbox **Do auto corrections after sequence** is checked, all correction functions, as background or shading correction, are performed after a complete sequence has been acquired. A background image will be acquired only once at the end of the sequence. If this checkbox is unchecked, the corrections will be made after acquisition of each image. It may depend on your experiment, which mode to use: The mode **Do auto correction after sequence** allows a much faster processing of an image sequence. We recommend to use it as default. However there may be circumstances which do not allow to use this mode, e.g. if the background image is changing after each acquisition. Then it is better to perform background subtraction immediately after an image

has been acquired with an newly acquired background image (see also "Corrections" on page 147 and "Sequence" on page 129).

Always display image during acquisition

If this option is selected each image acquired during sequence acquisition will be displayed. This will reduce the acquisition speed. We recommend not to select this option if sequences shall be acquired with high speed.

Warning on

If this option is selected warning messages will be displayed before sequence acquisition is started. It is recommended to have this option checked.

Acquisition Menu

Overview

In the **Acquisition** menu all commands related to image acquisition are listed. The **Acquisition** menu includes the commands **Live**, **Freeze**, **Acquire**, **Analog Integration**, **Photon Counting**, **Clear Image** and **Sequence**.

Acquisition menu

General

Four image acquisition modes (Live, Acquire, Analog Integration and Photon Counting) can be controlled from the **Acquisition** tab control.

There are two ways to open this control:

1. Choose the desired acquisition mode from the **Acquisition** menu.
2. Click on the desired acquisition mode button as described below:

***Live mode** is a mode in which images are acquired continuously. It is intended for monitoring images with maximum speed. It differs from other acquisition modes from display window handling. Live images are always displayed in the same window, while in other modes each new image can be displayed in a new display window.*

*In **Acquire mode** the C4880 and C4742-98 cameras acquire images while the camera readout is running in slow scan mode with a dynamic range of 12, 14 or 16 bit. It is intended for high precision measurements..*

There is also an Acquire mode for C4742-95 and analog video cameras. For these cameras Acquire mode behaves similar to the "Single exposure" mode of

Live mode with the exception of different display window handling (see "Live mode").

***Analog Integration** is a mode where a number of images from the camera is accumulated in the frame memory up to 16 or 32 bit depth.*

***Photon Counting** is a mode in which single photon events are added up in the frame memory. If the signal integration time is sufficiently long, a very high signal-to-noise ratio can be achieved. This mode also effectively suppresses certain crosstalk effects inherent to some image intensifier and streak tubes. A dynamic photon counting mode allows temporal analysis of photon counting images.*

Live mode	If the Live mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Live mode dialogue box is open, image acquisition in **Live** mode will be started. The acquisition parameters as shown in the Live mode dialogue box are used.
Freeze Live mode	**Live** mode stops. The last image will be stored.
Acquire	If the Acquire mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Acquire mode dialogue box is open, an image acquisition in **Acquire** mode will be executed. The acquisition parameters as shown in the Acquisition mode dialogue box are used.
Analog integration	If the Analog integration mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Analog integration mode dialogue box is open, an image acquisition in **Analog integration** mode will be executed. The acquisition parameters as shown in the Analog integration mode dialogue box are used.
Photon counting	If the Photon counting mode dialogue box is not opened, it will be opened as you click this button for the first time. If you click it while the Photon counting mode dialogue box is open, an image acquisition in **Photon Counting** mode will be executed. The acquisition parameters as shown in the Photon counting mode dialogue box are used. See "Basics of the Photon Counting Mode" on page 96.

If the Acquisition tab control is opened once, you can switch between the different modes either by selecting the desired mode from the main menu or by selecting the tab corresponding to the desired mode.

The acquisition buttons work different depending on the display status of the acquisition window:

If the window is closed, it will be opened by clicking one of the buttons.

If the window is already opened, the corresponding acquisition function will start after pressing an acquisition button. The acquisition will be made with the parameters set in the corresponding tab control.

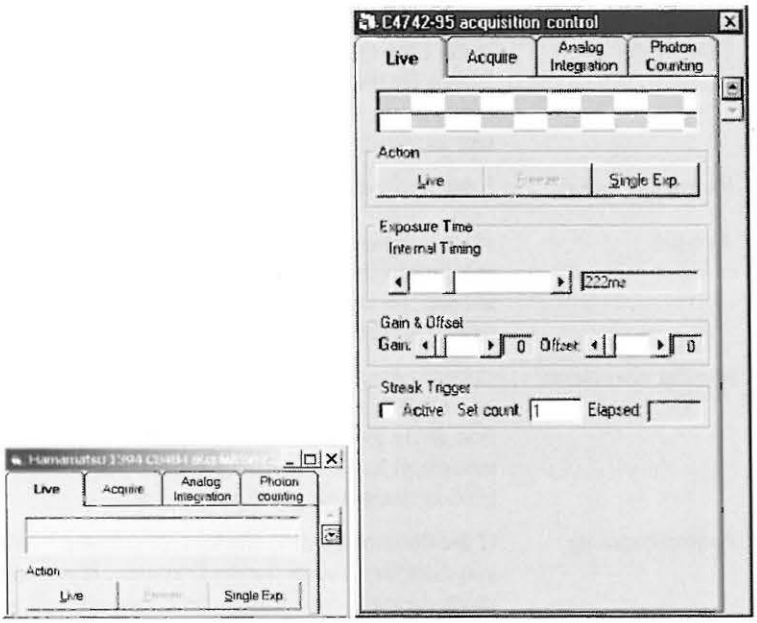
The Acquisition dialog can be changed in its size using the two pushbuttons on the right side of the dialogue box.
If you want to see the whole window with all options, you have to choose the largest size.
However after you have finished initial settings, you may not need to see all setting features of the control. Then you can make it smaller and display just the controls you need for your work (e. g. start acquisition and set exposure).

Each acquisition can be started by an hot-key and stopped by pressing the ESC key.

Hot-keys for start of an acquisition are:

Ctrl +L Live
Ctrl +F Freeze
Ctrl +A Acquire
Ctrl +I Analog integration
Ctrl +C Photon counting

–Sequential streak trigger method



Example: Acquisition control, Live mode (left smallest size, right largest size)

Basics of the Photon Counting Mode

***Photon Counting** is a mode in which single photon events are added up in the frame memory. If the signal integration time is sufficiently long, a very high signal-to-noise ratio can be achieved. This mode also effectively suppresses certain crosstalk effects inherent to some image intensifier and streak tubes. A dynamic photon counting mode allows temporal analysis of photon counting images.*

This chapter is divided into six parts. First you get an introduction to the photon counting principle, followed by a detailed description of the three counting methods (slice, peak, gravity) supported in this program. The next two parts give you a step- by step introduction to the set-up for photon counting. The last chapter describes the acquisition of dynamic photon counting images and analysis of this image type.

Conditions for Photon Counting Mode

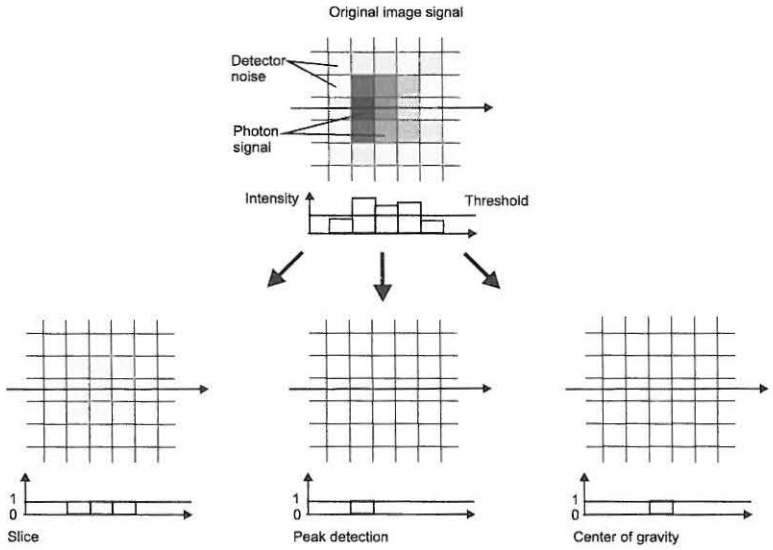
Photon Counting requires that the system sensitivity is high enough to see single photon events. This is not the case if a CCD camera is used without any other light amplification device. Such a light amplification device could be an image intensifier whose gain is set above a certain threshold.

Every Hamamatsu streak tube (with a few special exceptions) is equipped with an internal microchannelplate (MCP) which yields a sufficient amplification to perform photon counting.

Methods to Perform Photon Counting: Slice, Peak Detection, Gravity

Depending on the frame grabber hardware and the camera features several image processing methods, called **slice, gravity** and **peak detection** can be used to perform photon counting.

One common feature of all these methods is that only the portions of the image are regarded where the intensity exceeds a certain **threshold**. Only these portions contribute to the result. The setting of this threshold is depending on features of the camera and of the photon spots which are recorded by the camera.



Photon counting modes

Slice

The most simple method to perform photon counting is the **slice.** Every pixel which exceeds the threshold results in an increase of the frame-buffer value. Normally every photon entering the photocathode of a detector is imaged onto an area of several pixels (kind of spot). The frame-buffer intensity is incremented by one within this area. The size of this area depends on the resolution of the imaging system, the gain setting of the MCP (or the image intensifier) and the threshold level. This means the overall number of counts in an area of the frame-buffer is **not identical** to the number of photons. It is, however, equal to the number of detected photons times the average area a single photoelectron produces. As the pulse height of a photoelectron has a certain distribution that area has a certain distribution, as well. The number of detected electrons is also dependent on the overall system sensitivity, which means it is subject to shading effects.

Peak Detection

The **peak detection** mode avoids the disadvantages of the slice mode and yields only one count per photoelectron. The peak detection mode determines the pixel which has the maximum count rate within the photon spot area. Only the corresponding pixel-value in the image is incremented.

In **peak detection** and **gravity** mode there will be only one count in the image for every photon, thus Poisson statistics is well fulfilled and a statistical analysis can be done easily.

Center of Gravity Detection

Due to special features of a camera the exact position of a photon sometimes cannot be localised precisely with the peak detection method. Therefore it is sometimes necessary to perform a centre of gravity detection additionally to the peak detection. This is done by a special **gravity detection** mode. For example centre of gravity detection is recommended if there is a difference between odd and even pixels in either x or y direction due to the (interlaced) detector readout method.

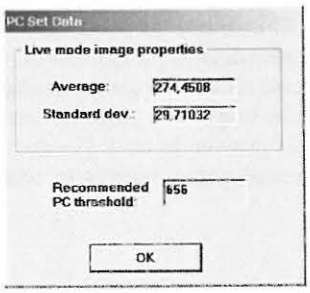
For digital cameras the peak detection mode or the slice mode can be used, whereas for analog video cameras the user has the choice between slice, peak detection and gravity mode. Photon counting is realised with the PC processor. Each frame is transferred with high speed to the PC RAM (50 - 100 Mbytes/sec) and then analysed. The count rate is only limited by the rate how often an image can be analysed. On modern computers the photon counting algorithm normally can be performed in real-time, which means every frame can be analysed.

Photon Counting Setup

Before you start photon counting image acquisition a suitable **threshold has to be set**. A sophisticated automatic setup routine has been implemented to automatically search for the most suitable threshold.

Open the Photon Counting dialogue and press **Setup** to start this routine. The program automatically acquires Live mode images and performs histogram analysis. Then it starts photon counting acquisition in test mode to get an optimal threshold for the given system. Finally it proposes certain values necessary for the photon counting, as described in the chapter "Photon Counting Condition" on page 99. Depending on the detector settings and type of detector, the procedure may take up to several ten seconds.

Note: If you did not perform Photon Counting Setup before you start photon counting acquisition, the system will prompt you to do so first. If you prefer to enter the threshold manually, you can answer No. This prompt is re-activated after you changed some parameters (like CCD exposure time) that can affect the proper threshold determination.



Photon counting, Proposed threshold after automatic threshold detection

Photon Counting Condition

In case that the photon spot areas of two photons overlap at the same image on the CCD they will be recognised as only one photon event. To avoid such a counting error the probability of a "two-photon event" should be low. A good indication of this probability is the percentage of the image which is "covered" by photons, in other words the percentage of the image which exceeds the threshold. The smaller this percentage is the smaller is the probability that a "new" photon hits an already recorded one. To keep this value small the "single photoelectron" probability should be made small by reducing the intensity of the light signal or minimising the single photoelectron spot size.

There is a display indicating the current percentage of pixels above the threshold in a specified ROI. This value should not exceed a few percent (5-7%).

Dynamic Photon Counting (time resolved 2-D photon counting)

The standard photon counting mode just accumulates the photons detected during the acquisition period. If you want to record also the time when a photon has been detected, you can use the Dynamic Photon Counting acquisition mode. If this mode is enabled, a DPC-type file will be generated where the x-y co-ordinate of each photon is registered as well as the time when it has been detected. In a later analysis step this file can be used for temporal analysis of photon counting images.

Acquisition

To activate the dynamic photon counting mode you have to select the item **Write dynamic photon counting file** in the menu Setup - Options- Display (see "Section Acquisition" on page "88).

Then start photon counting image acquisition as described above.

Before the acquisition will start, a file name selection dialogue will be shown. There you have to define the file name of the file where the image data will be stored. For these files a special file extension is used: *.dpc. In this file the x-y co-ordinates of each photon and the time (CCD frame number) when it was detected are stored. The time resolution is limited by the frame rate of the camera you use for image acquisition.

In parallel to the data recording in the DPC file, an accumulated photon counting image is generated as described above.

Analysis

There are two ways to use dynamic photon counting image files of the DPC format:

- If you want to see the accumulated photon counting image without using the time information you can load the file by selecting the "dpc file" format in the File – Open dialogue.
- If you want to analyze the temporal information of a DPC file you have to open the file by selecting the "dpc sequence" format in the File – Open dialogue. Then an image sequence will be generated from the file.

  After you opened the file a dialogue box is displayed where you can set several parameters of the image sequence which will be generated:

Dynamic photon counting load dialogue

In the upper part of this dialogue several basic parameters of the DPC file are displayed, like file size, exposure time of one frame, number of exposures and total acquisition time.

In the lower part you can set parameters of the sequence which will be generated:

Start frame sets the frame of the photon counting image at which the sequence will start. **Frames /image** defines the number of frames which will be accumulated for one image of the sequence and **No images** defines the number of images of the sequence.

Example (shown in above dialogue): If data were recorded with 15000 camera frames and you intend to split the data into 10 images, each image will be calculated from 1500 frames.

Set the **No images** parameter to define the number of sequence images you want to generate. If the number exceeds the value (No.exposures / Frames/image), the **No images** parameter will be automatically corrected. The header of the sequence images will show the time of the first image of the time frame.

Click **OK** to generate the sequence after you defined the sequence parameters. The generated sequence is a normal image sequence and can be treated in the standard fashion.

For information about handling and analysis of image sequences please refer to the chapter "Sequence" on page 129.

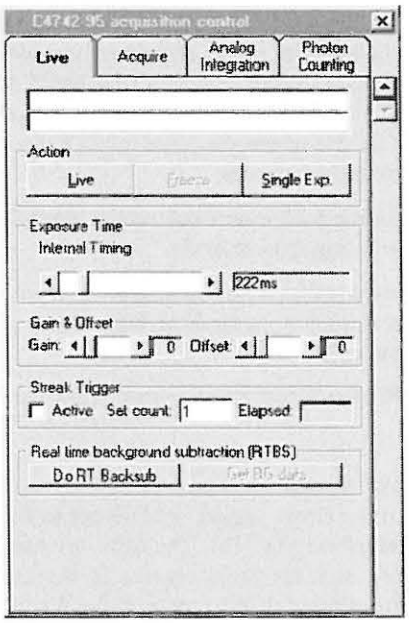
You can find a description of the DPC file format in Appendix F. You can use this if you want to use your own program for analysis of DPC files.

C4742-95 (ORCA)

This chapter describes the different acquisition modes of the C4742-95 camera models including the C4742-95-12ER .

Live Mode

Choose **Live** from the **Acquisition** menu to display the Live mode dialogue box.



C4742-95 Live mode dialogue box (large size)

Start Live mode

Freeze (Stop) Live mode

If the dialogue is open, you click **Live** to starts acquisition of images. Clicking **Freeze** stops the acquisition. With the **Exposure Time** slide bar the exposure time can be set.

Click **Single Exp.** to acquire a single image.

While Live mode is running all other acquisition commands are disabled.

When the **Freeze** push-button is pressed the last image is displayed and a intensity histogram of this image is calculated and displayed on the LUT tool. This serves for easy adjustment of LUT values (see "LUT Tool" on page 36 for details). The actual parameters are attached to the image. If the image is saved these parameters are kept in the header of the image file (see also "Save " on page 50).

A **QuickProfile** can be displayed during **Live** mode and after the acquisition has been terminated (see "QuickProfile" on page 43 for details).

Analog **Gain** and **Offset** of the camera can also be selected in this dialogue box. See also the chapter "C4742-95 Set-up" on page 56 and the camera manual for details on the operation modes.

Realtime background subtraction

*Realtime background subtraction is a operation where a background image is **continously subtracted** from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.*

To execute background subtraction you have to decide if you want to acquire a new background image or if you want to use any saved image as background: Open the dialogue **Background-Corrections** setup and select or deselect the checkbox **Get real-time backsub data from camera**. The way how to get the background image depends on this setting:

- **Get real-time backsub data from camera** is checked:
  Acquire a new background image in Live mode with your camera by clicking the button **Get BG data** in the **Live** menu while your camera is working in Live mode.

- **Get realtime backsub data from camera** is unchecked:
  Use a image from file as background image (use this function if you have stored a background image on your harddisk before). After you press the **Get BG data** in the **Live** dialogue a file selection dialogue will be opened. Select the file which you want to use as background image for realtime background subtraction.

To start realtime background subtraction press **Do RT Backsub** while the camera is working in Live mode.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Press **Do RT Backsub** again to stop realtime subtraction.

The **Streak Trigger** function will be automatically enabled (the box **Active** is checked), if the streak trigger setup is set to Enclosing or sequential mode (see "Trigger setup" on page 76). The exposure time will depend on the trigger signals received from the streak camera. In enclosing trigger mode a exposure will last until the number of triggers as defined under **Set count** or until the exposure time as set under **Exposure Time** has been reached (whichever comes first). The number of trigger counts which have been elapsed will be shown in the **Elapsed** textbox during an exposure.

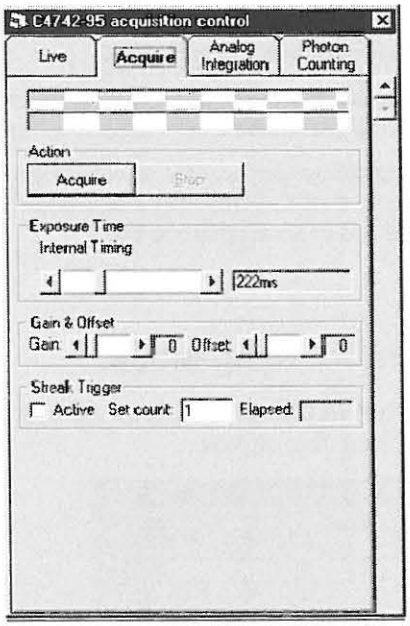
Streak Trigger is activated when camera is set to **Operate** mode in the Status control dialog or if the horizontal sweep is activated (if a dual time base extender is used).

Acquire Mode

Choose **Acquire** from the **Acquisition** menu to display the Acquire mode dialogue box.


Acquire an image in Acquire mode

The commands in this box are similar as explained under the chapter "This *chapter describes the different acquisition modes of the C4742-95 camera models including the C4742-95-12ER* Live Mode" on page 100, with the exception that there is no Live mode. Only single images can be acquired by pressing the **Acquire** button.

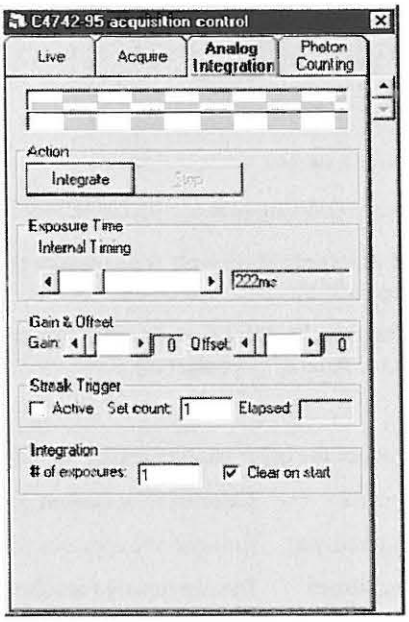


C4742-95 Acquire dialogue

Analog Integration Mode

Analog Integration with C4742-95 adds a specified number of frames in the frame memory.

Choose **Analog Integration** from the **Acquisition** menu to display the Analog integration dialogue box.



C4742-95 Analog integration

Its parameters are similar to those of the **Live** window (see "*This chapter describes the different acquisition modes of the C4742-95 camera models including the C4742-95-12ER* Live Mode" on page 100). Additionally you can specify

the parameter **# of Exposures** in the section **Integration**, which determines, how many images will be accumulated.

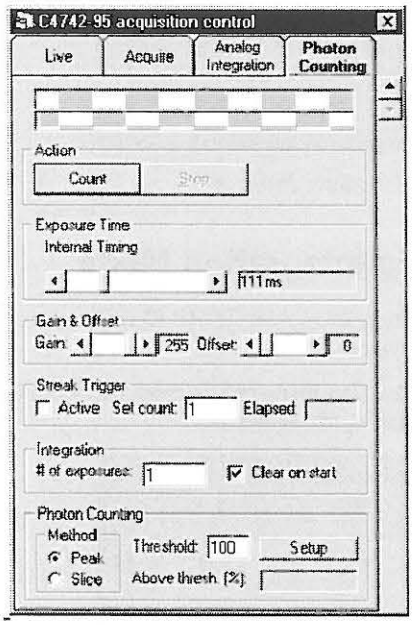
If **Clear on start** is checked, the last image which has been acquired will be cleared. If it is not checked, new images will be added to the last image.

Analog integration mode

Press **Integrate** to start acquisition and integration of a number of images (as defined under **# of Exposures)**. Each images is acquired with an exposure time as defined under **Exposure time**.

Photon Counting Mode

Choose **Photon Counting** from the **Acquisition** menu to display the **Photon Counting** dialogue box.



Photon counting dialogue box with C4742-95 camera

Besides of the standard controls for exposure time, Gain and Offset, there are the following parameters and commands:

Setup, Threshold, Clear on Start, Method Peak, Method Slice, # of Exposures, Above thresh. (%).

The meaning of the other parameters are as follows:

Threshold.:	Threshold for Photon counting
# of Exposures:	Number of exposures (images) to integrate
Clear on Start	The previously recorded image will be cleared before the next acquisition will be executed. If this checkbutton is unchecked, the new images will be added to the previously recorded ones.
Above thresh. (%):	An indication how many pixels in the ROI (or if no ROI is selected in the whole image) are above the threshold in percent. We recommend to keep this value below 5%.
Method (Slice,	Photon counting method

Peak)

If the **Streak Trigger** function is activated (the box **Active** has to be checked), the exposure time of one image will depend on the trigger signals received from the streak camera. A exposure will last until the number of triggers as defined under **Set count** or until the exposure time as set under **Exposure Time** has been reached (whichever comes first). The number of trigger counts which have been elapsed will be shown in the **Elapsed** textbox during an osure.

 Start photon counting by clicking this button

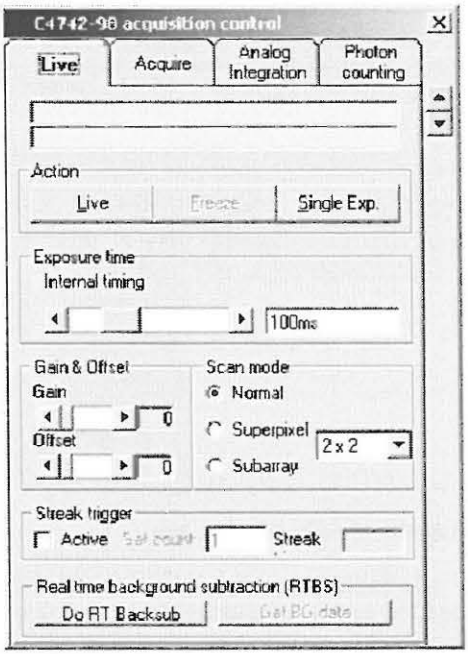
An photon counting acquisition can be started by clicking on the **Count** button.

C4742-98 (ORCA II)

This chapter describes the different acquisition modes of the C4742-98 and C4880-49 camera models

Live Mode

Choose **Live** from the **Acquisition** menu to display the Live dialogue box .



Live mode dialogue box with optional parameters

In LIVE mode the C4742-98 (ORCA II) is running continuously in fast scanning mode with a dynamic range of 12 bit. It may be used for set-up, focusing, alignment etc. where a fast update of the image is necessary.

 *Start Live mode.*

Click the **Live** push-button to start Live mode.

Live mode starts the camera, switches the frame grabber into continuous grab mode, selects the correct LUT.

 *Freeze (stop Live mode).*

Click **Freeze** to stop Live mode and **Single Exp.** to acquire a single image in fast scan mode.

While **Live** mode is running, the Live dialogue box allows to specify the camera parameters for the **Live** mode:

Exposure Time:

The exposure time can be changed by clicking on the slide bar **Exposure**. The range of exposure time which can be set depends on the camera model.

Analog Amplifier Gain and Offset:

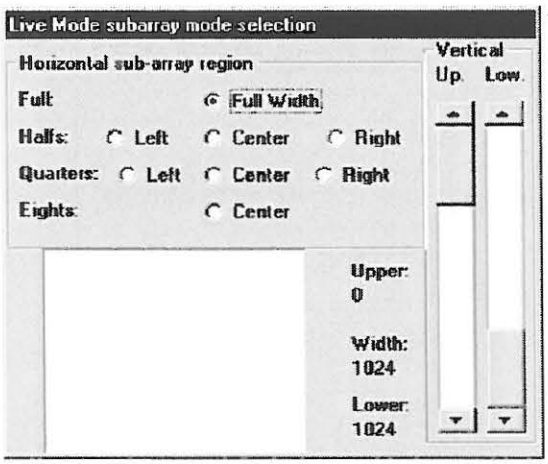
Analog **Gain** and **Offset** of the camera can also be selected in this dialogue box. See also the chapter "C4742-98 Set-up" on page 60 and the camera manual for details on the operation modes.

Scan Mode:

The **Scan mode** determines which part of the CCD sensor is read out by the system (see the C4742-98 manual for details). The selections are: normal (full area), subarray (a part of the sensor), or superpixel. Select one of the **Normal, Super-Pixel** or **Subarray** radio buttons within the frame **Scan Mode**.

Subarray

When the **Subarray** scan mode is selected, the **Subarray** dialogue box titled **Live mode Subarray selection** appears.



Live mode subarray selection box

The radio buttons in the frame **Horizontal sub-array region** control the part of the CCD sensor from where the image is read out. With the slide bars within the **Vertical** frame the vertical region of subarray scanning is defined. The left slide bar specifies the upper limit and the right slide bar controls the lower limit of subarray scanning. The rectangle in the centre of the bottom part of the **Subarray** dialogue box represents the full surface of the CCD sensor. The red rectangle inside this rectangle represents the relative position of the subarray area which is read out.

Note: The binning factor set in the super-pixel mode will be applied for the subarray mode as well.

While Live mode is running all other acquisition commands are disabled.

When the **Freeze** push-button is pressed the last image is displayed and a intensity histogram of this image is calculated and displayed on the LUT tool. This serves for easy adjustment of LUT values (see "LUT Tool" on page 36 for details). The actual parameters are attached to the image. If the image is saved these parameters are kept in the header of the image file (see also "Save as..." on page 50).

A QuickProfile can be displayed during **Live** mode (see "QuickProfile" on page 43 for details).

Realtime background subtraction

*Realtime background subtraction is a operation where a background image is **continuously subtracted** from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.*

To execute background subtraction you have to decide if you want to acquire a new background image or if you want to use any saved image as background: Open the dialogue **Background-Corrections** setup and select or deselect the checkbox **Get real-time backsub data from camera**. The way how to get the background image depends on this setting:

- **Get real-time backsub data from camera** is checked:
  Acquire a new background image in Live mode with your camera by clicking the button **Get BG data** in the **Live** menu while your camera is working in Live mode.
- **Get realtime backsub data from camera** is unchecked:
  Use a image from file as background image (use this function if you have stored a background image on your harddisk before). After you press the **Get BG data** in the **Live** dialogue a file selection dialogue will be opened. Select the file which you want to use as background image for realtime background subtraction.

To start realtime background subtraction press **Do RT Backsub** while the camera is working in Live mode.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Press **Do RT Backsub** again to stop realtime subtraction.

Acquire Mode

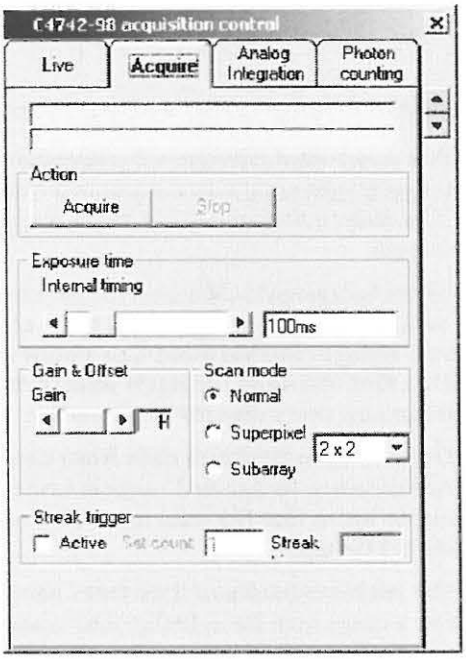
Choose **Acquire** from the **Acquisition** menu to display the Acquire mode dialogue box.


*Acquire an image in **Acquire** mode*

Clicking the **Acquire** push-button on the **Acquire** dialogue box starts one image acquisition cycle. The frame grabber is set to single frame snap mode. The correct LUT is selected.

While the acquisition is pending it can be interrupted by clicking **Stop.**

Camera parameters can only be selected while no acquisition is under progress.



Acquire mode dialogue box (maximum size)

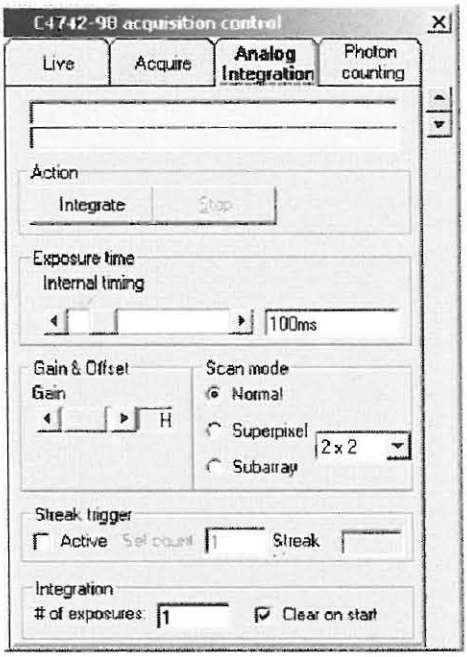
The dialogue is similar to the Live mode dialogue box with the following exception:

The **Acquire** mode has three gain settings instead of two: low, high, super high gain (select the **Low, High** or **Super high** gain with the Gain slider).

Analog Integration Mode

Choose **Analog Integration** from the **Acquisition** menu to display the Analog integration dialogue box.

Its parameters are similar to those of the **Live** window (see "Live Mode" on page 105). However there are additionally some controls to determine the special integration functions.



C4742-98 Analog Integration window

First of all you can specify how many images are to be added in the frame memory by entering a number in the text box **# of Exposures**. Additionally you can specify whether the existing image in the frame memory (current image) should be cleared on start of the function or not. This features enables you to continue an integration.
The **Analog Integration** function produces signed 16 bit images. Care must be taken not to exceed the 16 bit range. In this case overflow occurs. During background subtraction negative values can occur (see also the chapters "Basic operations" on page 36 and "Background Subtraction" on page 147 for further information).

Analog integration mode

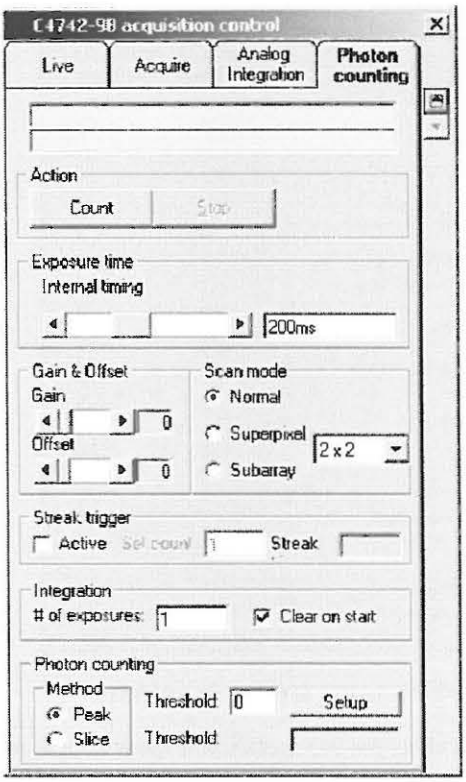
Press **Integrate** to start acquisition and integration of a number of images (as defined under **# of Exposures)**. Each images is acquired with an exposure time as defined under **Exposure time**.

The parameter **Exposure Time** contains the time for a single image acquisition (not the overall time) and the parameter **# of exposures**. is set to the number of integrated exposures. In a normal case (if the acquisition has not been interrupted) the overall exposure time is **# of Exposures** x **Exposure Time.**

Photon Counting Mode

Choose **Photon Counting** from the **Acquisition** menu to display the **Photon Counting** dialogue box.

When doing photon counting with the C4742-98, the camera is switched to fast scan mode. Since the mechanical shutter is closed during readout, the ratio of exposure time to readout time should be far below 1 in order not to waste too much time for the readout. On the other hand, the maximum intensity which can be counted is determined by the repetition rate (see above), so the exposure time should not be too high. Values between 200 milliseconds and 1 second may be recommended as starting values.



Photon counting dialogue box with C4742-98

Most of the parameters are identical to those of the **Live** mode dialogue box (see "Live Mode" on page 105). The differences are the following controls: **# of Exposures, Clear image on start, Threshold, Above thresh.,**

The meaning of the other parameters are as follows:

Threshold.:	Threshold for Photon counting
# of Exposures:	Number of exposures (images) to integrate
Clear on Start	The previously recorded image will be cleared before the next acquisition will be executed. If this checkbbutton is unchecked, the new images will be added to the previously recorded ones.
Above thresh. (%):	An indication how many pixels in the ROI (or if no ROI is selected in the whole image) are above the threshold in percent. We recommend to keep this value below 5%.
Method (Slice, Peak)	Photon counting method

 Start photon counting by clicking this button

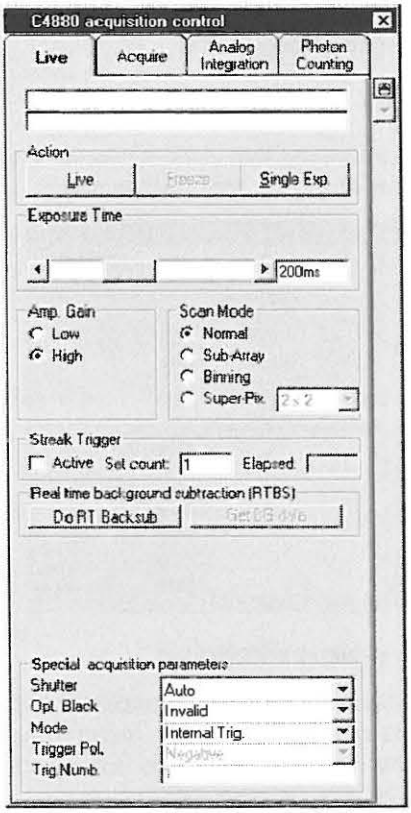
A photon counting acquisition can be started by clicking on the **Count** button.

C4880 (except C4880-80)

This chapter describes the different acquisition modes of the standard C4880, C5987, C7190-1x and C6918-05 camera types.

Live Mode with C4880 Cameras

Choose **Live** from the **Acquisition** menu to display the Live dialogue box



Live mode dialogue box with optional parameters

In LIVE mode the C4880 is running continuously in fast scanning mode with a dynamic range of 10 or 12 bit. It may be used for set-up, focusing, alignment etc. where a fast update of the image is necessary.

Start Live mode.

Click the **Live** push-button to start Live mode.

Live mode starts the camera, switches the frame grabber into continuous grab mode, selects the correct LUT.

Freeze (stop Live mode).

Click **Freeze** to stop Live mode and **Single Exp.** to acquire a single image in fast scan mode.

While **Live** mode is running, the Live dialogue box allows to specify the camera parameters for the **Live** mode:

Exposure Time:

The exposure time can be changed by clicking on the slide bar **Exposure**. The range of exposure time which can be set depends on the camera model.

Analog Amplifier Gain:

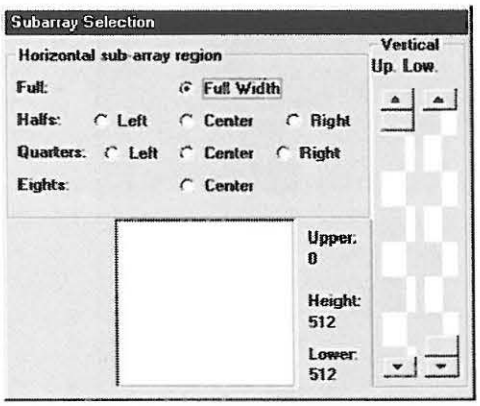
By clicking to the radio buttons within the frame **Amp. Gain** the user can select either **Low** or **High** camera amplifier gain.

Scan Mode:

The **Scan mode** determines which part of the CCD sensor is read out by the system (see the C4880 manual for details). The selections are: normal (full area), subarray (a part of the sensor), binning (additional binning), or superpixel. Select one of the **Normal, Subarray, Binning** or **Super-Pixel** radio buttons within the frame **Scan Mode**.

Subarray

When the **Subarray** scan mode is selected, the **Subarray** dialogue box titled **Live mode Subarray selection** appears.

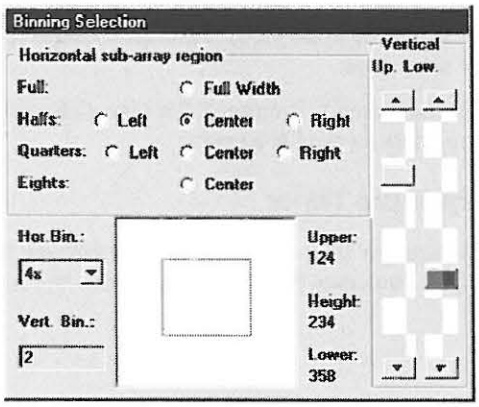


Live mode subarray selection box

The radio buttons in the frame **Horizontal sub-array region** control the part of the CCD sensor from where the image is read out. With the slide bars within the **Vertical** frame the vertical region of subarray scanning is defined. The left slide bar specifies the upper limit and the right slide bar controls the lower limit of subarray scanning. The rectangle in the centre of the bottom part of the **Subarray** dialogue box represents the full surface of the CCD sensor. The red rectangle inside this rectangle represents the relative position of the subarray area which is read out.

Binning

When the **Binning** scan mode is selected, the Binning dialogue box titled **LIVE Mode Binning selection** appears.



Live mode binning window

The **Binning** dialogue box is identical to the **Subarray** window except two additional controls: The **Hor. Bin.** (Horizontal Binning) combo box and the **Vert. Bin.** (Vertical Binning) edit box. By these controls the user can specify a binning factor in horizontal and vertical direction additionally .

While Live mode is running all other acquisition commands are disabled.

When the **Freeze** push-button is pressed the last image is displayed and a intensity histogram of this image is calculated and displayed on the LUT tool. This serves for easy adjustment of LUT values (see "LUT Tool" on page 36 for details). The actual parameters are attached to the image. If the image is saved these parameters are kept in the header of the image file (see also "Save as..." on page 50).

A QuickProfile can be displayed during **Live** mode (see "QuickProfile" on page 43 for details).

On the bottom part of the dialogue box you can find several additional settings in order to control several special acquisition parameter.

Shutter Control:

Auto, Open, or Close (Select one of **Auto**, **Open,** or **Close** from the **Shutter** combo-box).

If **Auto** is selected the mechanical shutter of the camera is automatically opened for every exposure and closed during every image readout (this is the default setting).

If **Open** is selected, the shutter will be always open, if **Close** is selected, the shutter will be always closed.

Optical Black:

Valid or Invalid (Select **Invalid** or **Valid** from the **Opt. Black** combo-box). Default setting is **Invalid**.

Mode:

Internal, External Time, External Event, or External Stop (Select **Internal Trig.**, **Ext.Trig./Time**, **Ext. Trig./Event, Ext. Trig./Level** or **Ext. Trig./Stop** from the **Mode** combo-box).

If **Internal Trig.** is selected the start of an acquisition and the exposure time is controlled from **HPD-TA** .

If **Ext.Trig./Time** is selected, the start of an acquisition is controlled from **HPD-TA** and the exposure time is controlled by an external signal (applied to the trigger input of the camera).

If **Ext. Trig./Event** is selected, exposure will start when **Live** has been clicked and an external trigger has been sent to the camera. If **Ext. Trig./Stop** is selected the exposure will start after you click **Live**. It ends as soon as an external signal is sent to the camera.

Finally, exposure time and start of exposures is controlled by an external trigger signal, if **Ext. Trig./Level** is selected.

Trigger Polarity:

Positive or Negative (Select **Positive** or **Negative** from the **Trigger Pol.** combo-box). You can select the trigger polarity for an external trigger signal which may be sent to the camera.

Trigger Number:

1 to 9999 (Input a number into the **Trig. Numb.** edit box). This parameter determines, how many trigger signals are counted before an exposure will end.

Realtime background subtraction

Realtime background subtraction is a operation where a background image is continuously subtracted from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.

To execute background subtraction you have to decide if you want to acquire a new background image or if you want to use any saved image as background: Open the dialogue **Background-Corrections** setup and select or deselect the checkbox **Get real-time backsub data from camera**. The way how to get the background image depends on this setting:

- **Get real-time backsub data from camera** is checked:
  Acquire a new background image in Live mode with your camera by clicking the button **Get BG data** in the **Live** menu while your camera is working in Live mode.
- **Get realtime backsub data from camera** is unchecked:
  Use a image from file as background image (use this function if you have stored a background image on your harddisk before). After you press the **Get BG data** in the **Live** dialogue a file selection dialogue will be opened. Select the file which you want to use as background image for realtime background subtraction.

To start realtime background subtraction press **Do RT Backsub** while the camera is working in Live mode.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Press **Do RT Backsub** again to stop realtime subtraction.

If the **Streak Trigger** function is activated (the box **Active** has to be checked), the exposure time will depend on the trigger signals received from the streak camera. A exposure will last until the number of triggers as defined under **Set count** or until the exposure time as set under **Exposure Time** has been reached (whichever comes first). The number of trigger counts which have been elapsed will be shown in the **Elapsed** textbox during an exposure.

When using **Streak Trigger** function it is recommended to select **Trigger mode - Single** in the **Streak Status** control box.

Acquire Mode for Standard C4880 Cameras

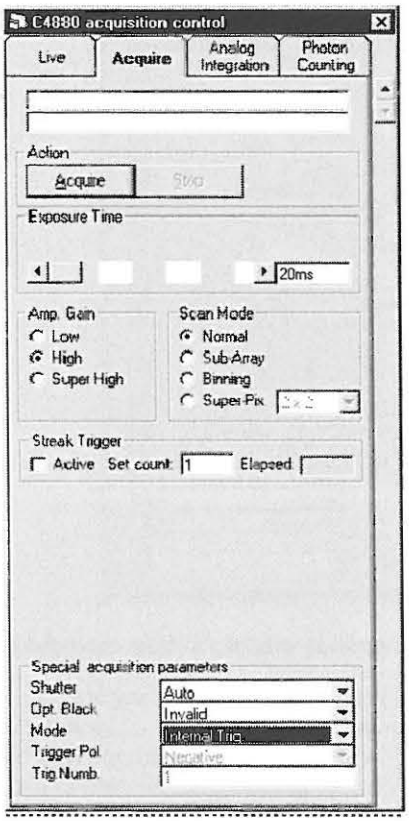
Choose **Acquire** from the **Acquisition** menu to display the Acquire mode dialogue box.

Acquire an image in Acquire mode

Clicking the **Acquire** push-button on the **Acquire** dialogue box starts one image acquisition cycle. The frame grabber is set to single frame snap mode. The correct LUT is selected).

While the acquisition is pending it can be interrupted by clicking **Stop.**

Camera parameters can only be selected while no acquisition is under progress.



Acquire mode dialogue box (maximum size)

The dialogue is similar to the Live mode dialogue box with the following exception:

The **Acquire** mode has three gain settings instead of two: low, high, super high gain (select the **Low, High** or **Super high** gain radio buttons).

Please refer to the "This chapter describes the modes of the standard C4880, C5987, C7190-1x and C6918-05 camera types.

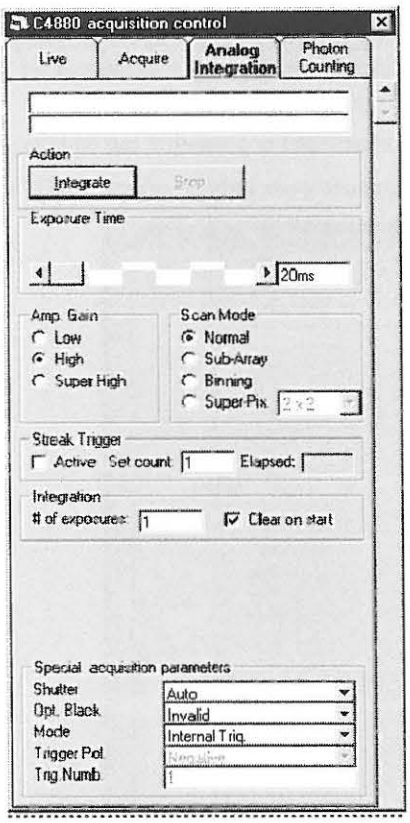
Live Mode with C4880 Cameras" on page 111 for a detailed description of the other functions of this dialogue.

Analog Integration Mode with C4880 Camera

Choose **Analog Integration** from the **Acquisition** menu to display the Analog integration dialogue box.

Its parameters are similar to those of the **Live** window (see " This chapter describes the modes of the standard C4880, C5987, C7190-1x and C6918-05 camera types.

Live Mode with C4880 Cameras" on page 111). However there are additionally some controls to determine the special integration functions.



Analog Integration window, without extended parameter settings

First of all you can specify how many images are to be added in the frame memory by entering a number in the text box **# of Exposures**. Additionally you can specify whether the existing image in the frame memory (current image) should be cleared on start of the function or not. This features enables you to continue an integration.
The **Analog Integration** function produces signed 16 bit images except if a camera with 16 bit A/D converter is used. With these cameras 32 bit images are produced. Care must be taken not to exceed the 16 bit range (resp.32 bit). In this case overflow occurs. During background subtraction negative values can occur (see also the chapters "Basic operations" on page 36 and "Background Subtraction" on page 147 for further information).

Analog integration mode

Press **Integrate** to start acquisition and integration of a number of images (as defined under **# of Exposures)**. Each images is acquired with an exposure time as defined under **Exposure time.**

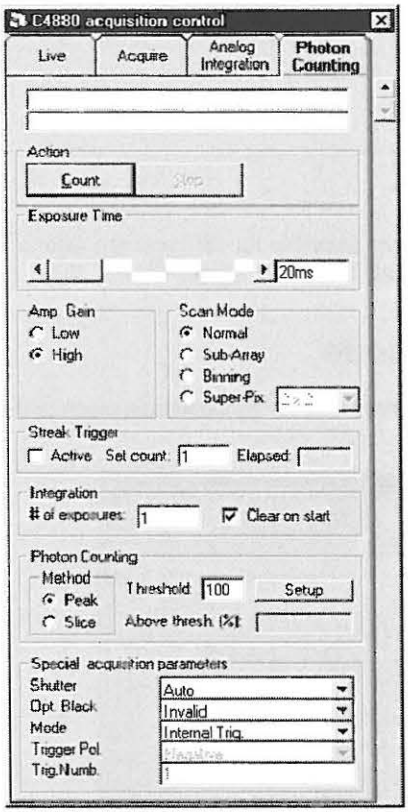
If the **Streak Trigger** function is activated (the box **Active** has to be checked), the exposure time of one image will depend on the trigger signals received from the streak camera. An exposure will last until the number of triggers as defined under **Set count** or until the exposure time as set under **Exposure Time** has been reached (whichever comes first). The number of trigger counts which have been elapsed will be shown in the **Elapsed** textbox during an exposure.

The parameter **Exposure Time** contains the time for a single image acquisition (not the overall time) and the parameter **# of exposures**. is set to the number of integrated exposures. In a normal case (if the acquisition has not been interrupted) the overall exposure time is **# of Exposures** x **Exposure Time.**

Photon Counting Mode with C4880 Camera

Choose **Photon Counting** from the **Acquisition** menu to display the **Photon Counting** dialogue box.

When doing photon counting with the C4880, the camera is switched to fast scan mode. Since the mechanical shutter is closed during readout, the ratio of exposure time to readout time should be far below 1 in order not to waste too much time for the readout. On the other hand, the maximum intensity which can be counted is determined by the repetition rate (see above), so the exposure time should not be too high. Values between 200 milliseconds and 1 second may be recommended as starting values.



Photon counting dialogue box with C4880

Most of the parameters are identical to those of the **Live** mode dialogue box (see " This chapter describes the modes of the standard C4880, C5987, C7190-1x and C6918-05 camera types.

Live Mode with C4880 Cameras" on page 111). The differences are the following controls: **# of Exposures, Clear image on start, Threshold, Above thresh.,**

The meaning of the other parameters are as follows:

Threshold.:	Threshold for Photon counting
# of Exposures:	Number of exposures (images) to integrate
Clear on Start	The previously recorded image will be cleared before the next acquisition will be executed. If this checkbbutton is unchecked, the new images will be added to the previously recorded ones.

Above thresh. (%):	An indication how many pixels in the ROI (or if no ROI is selected in the whole image) are above the threshold in percent. We recommend to keep this value below 5%.
Method (Slice, Peak)	Photon counting method

If the **Streak Trigger** function is activated (the box **Active** has to be checked), the exposure time of one image will depend on the trigger signals received from the streak camera. A exposure will last until the number of triggers as defined under **Set count** or until the exposure time as set under **Exposure Time** has been reached (whichever comes first). The number of trigger counts which have been elapsed will be shown in the **Elapsed** textbox during an exposure.

 Start photon counting by clicking this button

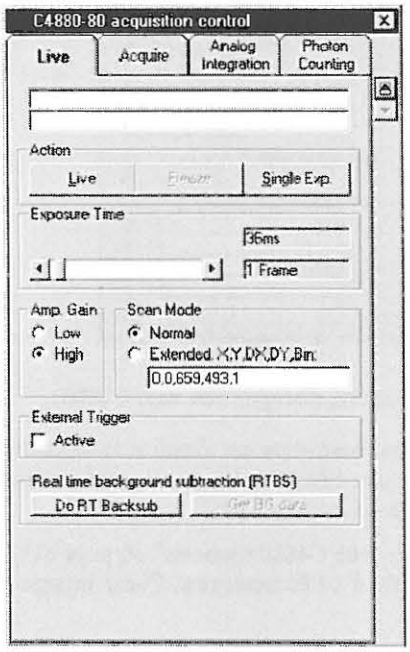
A photon counting acquisition can be started by clicking on the **Count** button.

C4880-80

This chapter describes the different acquisition modes of the C4880-8x cameras including the C6790-8x types

Live Mode

Choose **Live** from the **Acquisition** menu to display the Live mode dialogue box.



Live mode window with C4880-80


Start Live mode


Freeze (Stop) Live mode

When you click **Live** the camera starts acquisition of images. Clicking **Freeze** stops the acquisition.

A single exposure will be made if you click **Single Exp**.

With the **Exposure Time** slide bar on top of the dialogue box the exposure time can be set. The exposure time will be displayed in units of time and frames (please refer to the camera manual for details).

Further to the exposure time one can select between **Normal** scan mode and **Extended** scan mode. The **Extended** scan mode allows to select one (and only one) subarray region with any valid binning factor (1, 2, 4, 8, 16, or 32). The format of the entry in the **Extended** mode text box is as follows:

X,Y,DX,DY,Bin, where

X: left start co-ordinate of subarray region

Y: upper start co-ordinate of subarray region

DX: Width of subarray region

DY: Height of subarray region

Bin: Binning factor

Example 1: Full area is read out with 4 x 4 binning: 0,0,659,493,4

Example 2: A subarray, starting at pixel 100,50 with a width of 100 x 100 pixel and 2 x 2 binning is read out: 100,50,100,100,2

The camera can be controlled by an external trigger signal, if the **Active** checkbox is checked.

Please refer to the C4880-80 manual for details on the scan mode.

While Live mode is running all other acquisition commands are disabled.

When the **Freeze** push-button is pressed the last image is displayed and a intensity histogram of this image is calculated and displayed on the LUT tool. This serves for easy adjustment of LUT values (see "LUT Tool" on page 87 for details). The actual parameters are attached to the image. If the image is saved these parameters are kept in the header of the image file (see also "Save as.." on page 50).

A **QuickProfile** can be displayed during **Live** mode as well as after acquisition has been terminated (see "QuickProfile" on page 43 for details).

Realtime background subtraction

*Realtime background subtraction is a operation where a background image is **continuously subtracted** from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.*

To execute background subtraction you have to decide if you want to acquire a new background image or if you want to use any saved image as background: Open the dialogue **Background-Corrections** setup and select or deselect the checkbox **Get real-time backsub data from camera**. The way how to get the background image depends on this setting:

- **Get real-time backsub data from camera** is checked:
  Acquire a new background image in Live mode with your camera by clicking the button **Get BG data** in the **Live** menu while your camera is working in Live mode.
- **Get realtime backsub data from camera** is unchecked:
  Use a image from file as background image (use this function if you have

stored a background image on your harddisk before). After you press the **Get BG data** in the **Live** dialogue a file selection dialogue will be opened. Select the file which you want to use as background image for realtime background subtraction.

To start realtime background subtraction press **Do RT Backsub** while the camera is working in Live mode.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Press **Do RT Backsub** again to stop realtime subtraction.

Acquire Mode

Choose **Acquire** from the **Acquisition** menu to display the Acquire mode dialogue box.

Acquire an image in Acquire mode

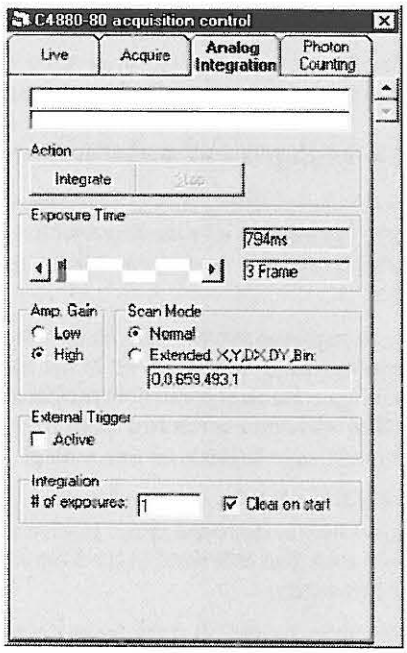
The commands in this box are similar as explained under the chapter "This chapter describes the different acquisition modes of the C4880-8x cameras including the C6790-8x types

Live Mode" on page 118, with the exception that the camera will acquire images in slow scan mode and there a 3 types of amplifier gain settings.

Analog Integration Mode

Analog Integration with C4880-80 adds a specified number of frames in the frame memory.

Choose **Analog Integration** from the **Acquisition** menu to display the Analog integration dialogue box.



C4880-80 Analog integration

Its parameters are similar to those of the **Live** window (see "This chapter describes the different acquisition modes of the C4880-8x cameras including the C6790-8x types

Live Mode" on page 118). Additionally you can specify the parameter **# of Exposures** in the section **Integration**, which determines, how many images will be accumulated.

If **Clear on start** is checked, the last image which has been acquired will be cleared. If it is not checked, new images will be added to the last image.

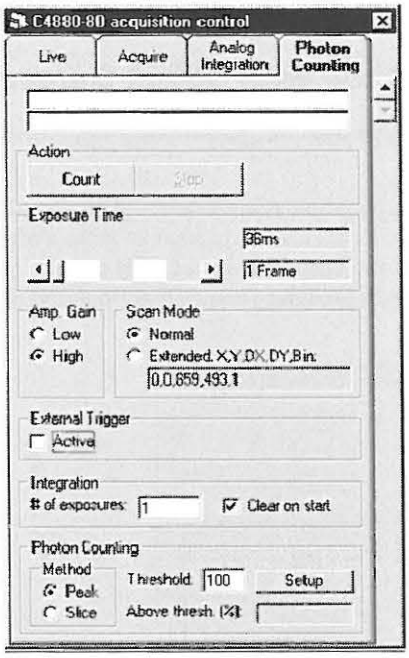
 Analog integration mode

Press **Integrate** to start acquisition and integration of a number of images (as defined under **# of Exposures)**. Each images is acquired with an exposure time as defined under **Exposure time**.

Photon Counting

Choose **Photon Counting** from the **Acquisition** menu to display the **Photon Counting** dialogue box.

When doing photon counting with the C4880-80, the camera is switched to fast scan mode.



Photon counting dialogue box with C4880-80

Most of the parameters are identical to those of the **Live** mode dialogue box (see " This chapter describes the different acquisition modes of the C4880-8x cameras including the C6790-8x types

Live Mode" on page 118). The differences are the following controls: **# of Exposures, Clear image on start, Threshold, Above thresh.,**

The meaning of the other parameters are as follows:

Threshold.: Threshold for Photon counting

# of Exposures: Number of exposures (images) to integrate

Clear on Start The previously recorded image will be cleared before the next acquisition will be executed. If this check-button is

unchecked, the new images will be added to the previously recorded ones.

Above thresh. (%): An indication how many pixels in the ROI (or if no ROI is selected in the whole image) are above the threshold in percent. We recommend to keep this value below 5%.

Method (Slice, Peak) Photon counting method

 Start photon counting by clicking this button

A photon counting acquisition can be started by clicking on the **Count** button.

C8800

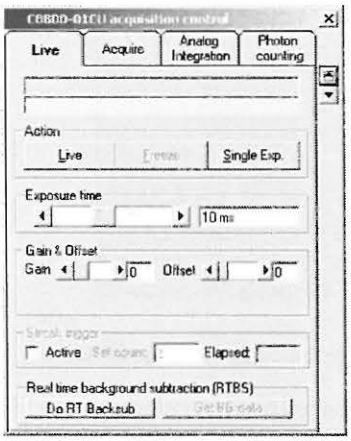
Live Mode with C8800 Cameras

Choose **Live** from the **Acquisition** menu to display the Live mode dialogue box.

 *Start Live mode*

 *Freeze (Stop) Live mode*

In this dialogue box you can select **Live, Freeze, Single Exp.** or **Close**. The program assumes that the camera acquires already images when you start this command and **HPD-TA** immediately starts to read these images. When you click **Freeze** the image acquisition stops and the last image acquired is displayed.



Live mode dialogue box for C8800 cameras

A **QuickProfile** can be displayed during **Live** mode and after image acquisition has been terminated (see "QuickProfile" on page 43 for details).

Analog **Gain** and **Offset** of the camera can also be selected in this dialogue box. See also the camera manual for details on the operation modes.

Realtime background subtraction

*Realtime background subtraction is a operation where a background image is **continously subtracted** from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.*

To execute background subtraction you have to acquire a new background image Press **Store BG** in order to store the actual image as background image.

To activate realtime background subtraction check the **BG Sub** checkbox.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Unchek the **BG Sub** checkbox again to stop realtime subtraction.

Set the **BG offset** value in order to set an additional offset value to the background signal.

Recursive Filtering

The camera has a recursive filter function built in. Recursive filter or rolling average help to noise at the cost of time resolution.

Check the checkbox **Recursive filter** to activate recursive filtering and select the filtering factor in the **Number** slider. The higher the number the better the noise will be reduced.

Acquire Mode with C8800 Camera

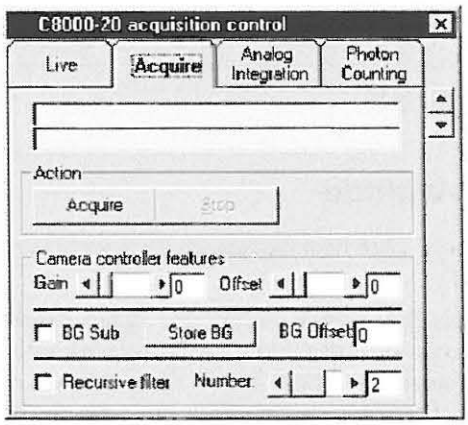
Choose **Acquire** from the **Acquisition** menu to display the Acquire mode dialogue box.


Acquire an image in Acquire mode

Clicking the **Acquire** push-button on the **Acquire** dialogue box starts one image acquisition cycle. The frame grabber is set to single frame snap mode. The correct LUT is selected).

While the acquisition is pending it can be interrupted by clicking **Stop.**

Camera parameters can only be selected while no acquisition is under progress.



Acquire mode dialogue box for C8800 cameras

Exposure time can be set with the slider **Exposure**.

Analog **Gain** and **Offset** of the camera can also be selected in this dialogue box. See also the camera manual for details on the operation modes.

Realtime background subtraction

Realtime background subtraction is a operation where a background image is ***continously subtracted*** *from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.*

To execute background subtraction you have to acquire a new background image Press **Store BG** in order to store the actual image as background image.

To activate realtime background subtraction check the **BG Sub** checkbox.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Uncheck the **BG Sub** checkbox again to stop realtime subtraction.

Set the **BG offset** value in order to set an additional offset value to the background signal.

Recursive Filtering

The camera has a recursive filter function built in. Recursive filter or rolling average help to noise at the cost of time resolution.

Check the checkbox **Recursive filter** to activate recursive filtering and select the filtering factor in the **Number** slider. The higher the number the better the noise will be reduced.

Note: Analog integration and Photon Counting modes are also supported for this camera. The operation procedures are equivalent to the procedures described for analog video cameras (see "Analog Integration" on page 126 and "Photon Counting Mode" on page 127).

Analog Video Cameras

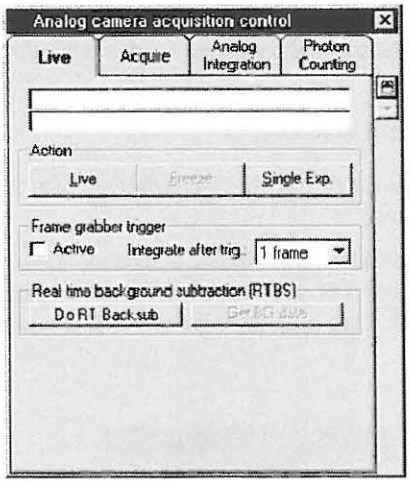
Live Mode

Choose **Live** from the **Acquisition** menu to display the Live mode dialogue box.


Start Live mode


Freeze (Stop) Live mode

In this dialogue box you can select **Live**, **Freeze**, **Single Exp.** or **Close**. The program assumes that the camera acquires already images when you start this command and **HPD-TA** immediately starts to read these images. When you click **Freeze** the image acquisition stops and the last image acquired is displayed.



Live mode dialogue box for analog cameras

A **QuickProfile** can be displayed during **Live** mode and after image acquisition has been terminated (see "QuickProfile" on page 43 for details).

Realtime background subtraction

*Realtime background subtraction is a operation where a background image is **continously subtracted** from the acquired live images. This function can be used to subtract a background like mottle image, intensity offset signals etc. from images.*

To execute background subtraction you have to decide if you want to acquire a new background image or if you want to use any saved image as background: Open the dialogue **Background-Corrections** setup and select or deselect the checkbox **Get real-time backsub data from camera**. The way how to get the background image depends on this setting:

- **Get real-time backsub data from camera** is checked:
  Acquire a new background image in Live mode with your camera by clicking the button **Get BG data** in the **Live** menu while your camera is working in Live mode.
- **Get realtime backsub data from camera** is unchecked:
  Use a image from file as background image (use this function if you have stored a background image on your harddisk before). After you press the **Get BG data** in the **Live** dialogue a file selection dialogue will be opened. Select the file which you want to use as background image for realtime background subtraction.

To start realtime background subtraction press **Do RT Backsub** while the camera is working in Live mode.

The subtracted image is now displayed. In many cases you may have to change the contrast settings with the LUT tool now in order display the resulting images in good contrast.

Press **Do RT Backsub** again to stop realtime subtraction.

One can synchronise the acquisition to external events by using **the Frame grabber trigger**. Enable this function by selecting the **Active**. checkbox. After you clicked **Live** the system waits for the next external trigger signal. Then acquisition starts. It is possible to average several frames if you select the parameter **Integrate after trig**. to 2, 4 or 8 frames. This is especially useful, if you

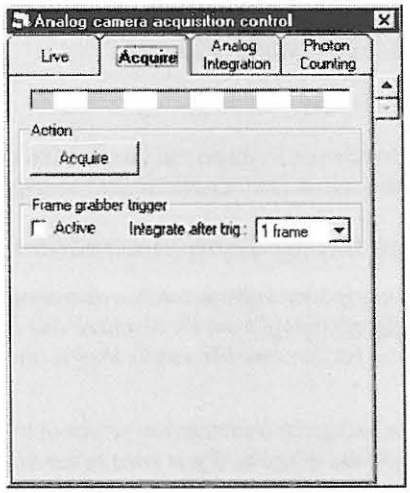
press Single exp. and want to be sure to get the whole signal from an image intensifier including the phosphor screen afterglow signal.

Acquire mode

Choose **Acquire** from the **Acquisition** menu to display the Acquire mode dialogue box.


Acquire an image in Acquire mode

The commands in this box are similar as explained under the chapter " " on page **Fehler! Textmarke nicht definiert.** with the exception that there is no Live mode. Only single images can be acquired by pressing the **Acquire** button.

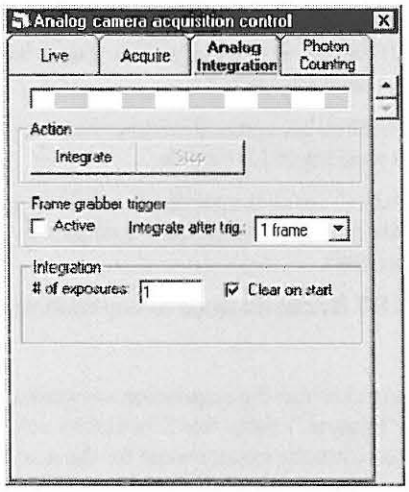


Acquire mode dialogue for analog video cameras

Analog Integration

Analog Integration with analog video cameras adds up video frames in the frame memory during a specified time or number of frames.

Choose **Analog Integration** from the **Acquisition** menu to display the Analog integration dialogue box.



Analog Integration window for analog cameras

Its parameters are similar to those of the **Live** window. Additionally you can specify the parameter **# of Exposures** in the section **Integration**, which determines, how many images will be accumulated. Each exposure takes 33 ms in case you use an EIA type camera and 40 ms if you use a CCIR type camera.

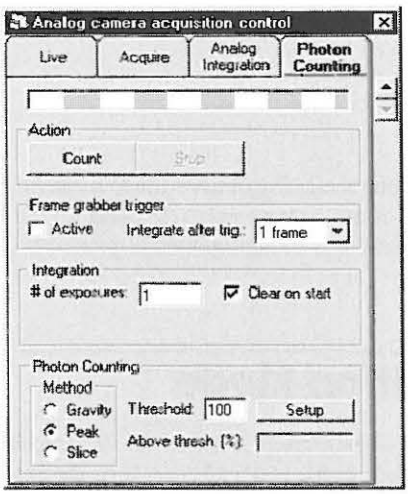
If **Clear on start** is checked, the last image which has been acquired will be cleared. If it is not checked, new images will be added to the last image.

Press **Integrate** to start acquisition and integration of a number of images (as defined under **# of Exposures)**..

Photon Counting Mode

Choose **Photon Counting** from the **Acquisition** menu to display the **Photon Counting** dialogue box.

When doing photon counting with an analog camera, the frame rate is fixed (it is defined by the video standard, e.g. for CCIR it is 25 Hz).



Photon counting dialogue box for analog cameras

There are the following parameters and commands:

Setup, Thres., Photon counting method, # of Exposures, Clear on Start, Frame grabber trigger, Integrate after Trigger, Above threshold.

If the **Setup** command is selected you will be guided through a procedure to find the optimum threshold parameter for photon counting. The program automatically acquires Live mode images (see " " on page **Fehler! Textmarke nicht definiert.**) and performs histogram analysis. Finally it proposes certain values necessary for the photon counting, as described in the chapter "Photon Counting Condition" on page 99. Depending on the detector settings and type of detector, the procedure may take up to several seconds.

The meaning of the other parameters are as follows:

Threshold:	Threshold for Photon counting
# of Exposures:	Number of exposures (images) to integrate
Clear on Start	The previously recorded image will be cleared before the next acquisition will be executed. If this check-button is unchecked, the new images will be added to the previ-

ously recorded ones.

Frame grabber trigger:	The frame grabber synchronises the acquisition to external trigger events
Integrate after Trigger	Here you can define, how many frames shall be averaged after each Frame trigger event. This function is only available if the IC-PCI frame grabber with AM-VS board is used.
Above thresh. (%):	An indication how many pixels in the ROI (or if no ROI is selected in the whole image) are above the threshold in percent.
Photon Counting Method (slice, peak, gravity)	Here you can select the photon counting method

 Start photon counting by clicking this button

An photon counting acquisition can be started by clicking on the **Count** button.

Freeze

If the camera is running in **Live** mode it can be stopped by selecting the **Freeze** command of the Acquire menu (or press Ctrl+F keys). The last image which has been acquired will be kept in the image memory.

Changing the Acquisition Mode

A full set of parameters is stored for all acquisition modes (e.g. **Live** and **Acquire**) mode and is restored every time the acquisition mode is changed.

The correct LUT is selected and the previously selected settings for this mode of the LUT are restored.

In case of the C4880 the scan area is saved and restored when switching from one acquisition mode to another. If subarray or binning mode has been selected last time, the appropriate dialogue box is shown with the correct label. All dialogue boxes for all acquisition modes can be kept open simultaneously at the screen, and it is convenient to switch from one to the other mode just by clicking to the corresponding push-buttons.

When an acquisition has ended (either by clicking to the **Freeze** push-button in **Live** mode or at the end of the readout in the other modes) a histogram is calculated and displayed on the LUT tool, and the corresponding acquisition parameters are copied into the image status and displayed in the Image Status dialogue box if the **Image status** command has been selected.

Clear Image

The **Clear Image** command clears the image data.

Sequence

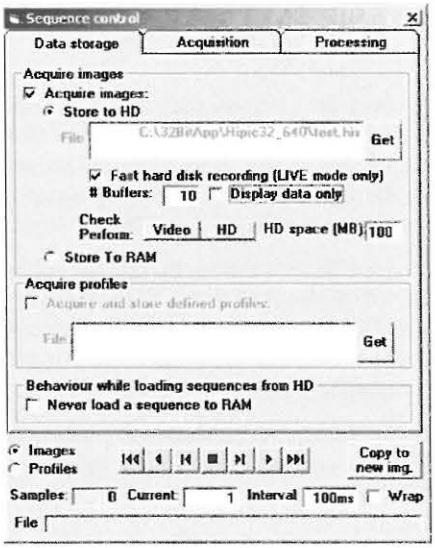
In sequence acquisition mode a series of images can be acquired. Dependent on the settings the sequence is recorded to the computer RAM (fast method, but length of recording is limited by RAM size) or to hard disk. The sequence function can save and load sequences and replay the sequence. Also sequences of intensity profiles can be recorded.

Note: At any time only **one** sequence can be active (either image or profile sequence).

Setting the acquisition parameters

Before you can start image or profile sequence acquisition, you have to make a few initial settings.

Open the sequence dialogue by clicking **Sequence** in the **Acquisition** menu. Then select the **Data storage** tab.



Sequence Data storage dialogue

Then you can choose if you want to record images or Profiles on computer RAM or on a disk.

Select **Acquire Images** to store image sequences.

If you select **Store to RAM** the sequence will be recorded to the computer RAM. Use this in order to acquire a sequence with the highest speed. However you may also have to consider that the RAM is limited so the number of images you can record is limited.

If you select **Store to HD**, the images will be stored on your hard disk drive. There are two methods to save these data:

Standard mode: Image files are saved under the file name as defined under the file text box on your hard disk. Storing images to the hard disk is not as fast as other recording methods. This method is recommended if you work in "Acquire" or "Integration" mode.

Fast hard disk recording (LIVE mode only): Image files are saved in a special file format (HIS format) on your hard disk. This method is faster than the standard mode, but it is limited to images acquired in LIVE mode.

Note : Please consider following limitations of the **Fast hard disc** recording mode: It applies to images acquired in Live mode only. It applies only to sequences acquired at full speed. If the grabber mode which you use supports image buffering (PCDig, National Instruments boards, DCAM drivers), the buffers can be used and the buffer size can be defined by the user. A precise time stamp can be expected only if PCCamlink or PCDig frame grabber boards are used. With other configurations the time stamp may be not accurate.

Check the **Fast hard disk recording (LIVE mode only)** checkbox to enable this mode. Define the image sequence file name by pressing the **Get** button and selecting a file name. The file type has to be HIS format.

If you additionally check **Display data only**, the bit depth of the images will be limited to 8 bit per pixel. The images will be saved in a contrast setting as displayed on the screen.

Please make sure that the LUT setting is reasonable before you acquire an image with this option selected. If you are using a camera with more than 8 bit per pixel output, the **Display data only** function will reduce the amount of data to be saved. Even a computer with limited performance may be fast enough to save such sequences.

You can check the performance of your recording system for the fast hard disk recording mode. If you click the **Check perform. Video** button, the time needed to display an image on your monitor will be measured and displayed. You may de-select the "Always display image during acquisition" option on the acquisition options dialogue (see "Image Sequence acquisition" below)

If you click on **Check perform. HD** the performance (byte per second) of your hard disk will be checked with a file size as determined by the **HD space (MB)** parameter. Before you click on the **HD** button you have to insert a reasonable figure in the **HD space (MB)** text box. The measurement may take several minutes depending on your computer performance and file size selected.

The result of the analysis is shown in a table. You can use this information to check if your configuration is fast enough to record images in LIVE mode on your hard disk.

If you select **Acquire and store defined profiles**, all intensity profiles with defined and displayed ROIs will be stored. You have to select the file name in the file text box. Profile sequences are always stored to disk.

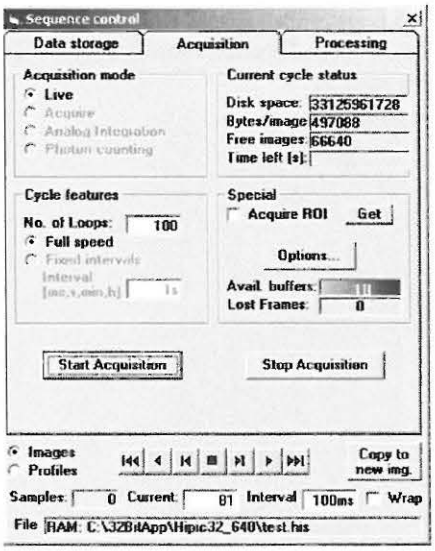
Image Sequences

Image Sequence acquisition

To acquire a sequence proceed as follows:

First of all start the acquisition for which you want to record a sequence (**Live, Analog Integration, Photon Counting** or **Acquire** mode) and adjust exposure time, scan area, focus etc.

Then choose the **Acquisition** tab from the **Sequence control** menu.



Sequence acquisition dialogue box.

The sequence acquisition dialogue box consists of two parts, the lower one containing controls for the sequence display and the upper one containing controls for the sequence acquisition.

In the upper right half of the dialogue box you find some information about the current system status:

Disk space displays the actual free space on disk.

Bytes / image displays the number of bytes which one image occupies.

Free images display the estimated number of images which can be saved to disk, before the disk gets full.

Time left (s) displays the number of seconds until start of the next acquisition. This is useful if you use long intervals.

The program calculates the number of bytes needed for all images in the series and outputs an informative message if the remaining space on disk is not sufficient.

At first you have to select the **Acquisition mode** you want to use and the number of images you want to record (**No. of loops**).

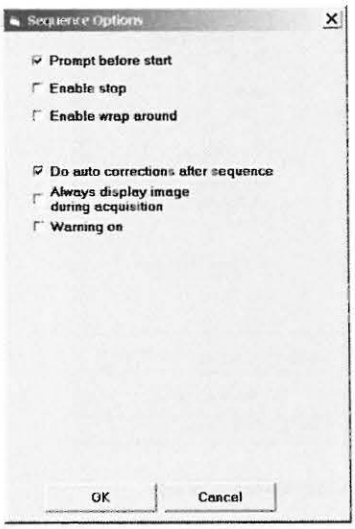
Then you can select the timing of the sequence. Choices are **Full speed** or **Fixed intervals**. If you select **Full speed** the camera is running freely and the sequence is recorded with this timing. Immediately after the acquisition and storage of an image the next acquisition will be executed. The time interval is just defined by the exposure time, the readout time, the response time of the mechanical shutter and the data storage time.

Note: Fast disk recording works with **Live** mode and **Full speed** setting only.

If you select **Fixed intervals** you can define the interval from one acquisition to the next (examples of allowed formats: 500ms, 2.5s, 1m). This interval should of course be larger than the time needed for acquisition, readout and data storage.

It is possible to acquire only a part of the image by selecting the checkbox **Acquire ROI**. In order to use this function, you have to define a ROI first by using the area ROI tool. Then click **Get ROI** to select (activate) the ROI.

Further settings of the sequence acquisition mode can be set by clicking on the **Options..** button. Then the Options dialog will be opened. There you can do following settings:



Sequence Options dialog

After the sequence acquisition has been started, the system will first do several procedures in order to prepare your computer for the acquisition (e.g. allocate memory). Therefore some time will pass before the first image will be acquired. Check **Prompt before start** in the **Setup – Options** dialogue if you want to get a message after preparation has been finished and before the first image will be recorded (for details see " Section Acquisition" on page 88).

Set **Enable stop** in order to enable the possibility to stop the image acquisition at a desired time. On older computers this function may sometimes slow down the sequence acquisition a little bit.

Wrap around mode is only available if **Store in RAM** is selected (dialogue Sequence – Data storage) and if following settings are made:

Set **Enable wrap around** in order to enable the option for wrap around image acquisition. The related checkbox will be displayed in the sequence acquisition window (for details see " Section Acquisition" on page88).

Warning: If Enable stop is not checked, the acquisition cannot be stopped before it has been ended or before it has been terminated by a **UserFunction**. This behaviour was implemented to allow error free acquisition with fast timing. Be careful not to specify very long intervals.

Always display image during acquisition is selected, each image is displayed after acquisition. This may sometimes slow down the sequence acquisition speed. If this function is not enabled, images will be displayed after sequence acquisition is finished.

If **Warning on** is selected several warning messages may be displayed before acquisition start and after acquisition. Only experienced users should deselect this item.

If **Wrap around** is selected, the sequence acquisition will be continued until you stop the acquisition by pressing the **Stop acquisition** button or by an external event. Sequence acquisition in **Wrap around** mode works as follows: Images are acquired as described above **No. of loops** has been reached. The next image will be then stored in the first frame buffer again, thus overwriting

the image which was recorded first. Then the next frame will be overwritten and so on.

If you want the images being automatically background-subtracted or shading-corrected use the **Auto Backsub** and **Auto Shading** options (see "Options" on page 86) and select the **Do auto corrections after sequence** option.

For **Fast hard disk recording** following parameters are important:

Available Buffers shows how many images can be saved in the buffer memory. This is depending on the actual configuration and camera settings. The larger the buffer is, the less critical it will be to store all images. The parameter **Lost frames** indicates how many images have been lost during sequence acquisition. If this figure is 0, all consecutive images coming from the cameras could be saved.

Image Sequence display

To control the display and replay of a sequence the controls on the lower part of the sequence dialogue box are used. If you run the program in demo mode you still can display and replay existing sequences.

Unless a sequence is already opened, you have to open a sequence using the File – Open dialogue or acquire a new sequence.

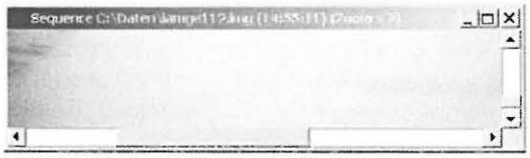
Select **Images** in the Sequence control – Acquisition dialogue to display a sequence of images (only necessary if a image sequence and a profile sequence are currently loaded).

The controls in the center are used to specify the image within the sequence. The text box **Current** shows the index of the image currently shown. You can enter the desired image number, switch to the first (with "|<<") or last image (with ">>|") or switch to the next (with ">|") or previous image (with "|<"). You can automatically replay the sequence backward or forward with the controls > and <. The parameter **Interval** defines the time for which each image will be displayed.

If the parameter **Wrap** is selected, the sequence display will be continued until the user stops it by pressing the (=Stop) button.

If you want to extract a single image from the sequence you can use the push-button **Copy to new image** to create a single image with the same data as the current image. This is displayed in a separate window.

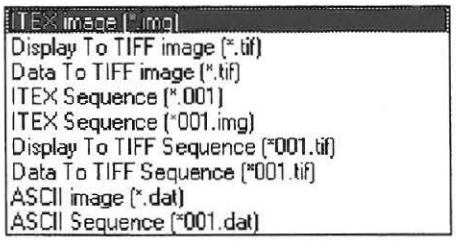
The currently displayed image within the sequence contains some useful information in the window title bar. The word "Sequence", the file name (or the image number if the sequence is not yet saved), the time and the zooming factor. If the image is the first image within a sequence the time parameter shows the time when the image was acquired (11:08:09). If it is another image it shows the offset to the first image in milliseconds (e.g. 147 ms). Therefore an exact timing can be reconstructed. If **Full speed** was selected during acquisition the time when the image has been read out completely is registered, if **Fixed Timing** was selected the start time of the acquisition command is registered. This is normally more precise.



Title bar of a sequence image

Sequence image file naming conventions

When you select the **Save as..** function within the **File** menu you will find several formats to save image sequences:



***Save as..** file type list*

1. ITEX sequence
All images of a sequence are saved to separate ITEX-files. These files are only linked together by the naming convention. There are two possible naming conventions:

1.1. *.001 format

Example1: Starting name: TEST.001
Sequence: TEST.001, TEST.002, TEST.003 ...
Example2: Starting name: TEST.031
Sequence: TEST.031, TEST.032, TEST.033 ...
Note: This format should not be used any more, since it may not be supported in future versions of this program. It is only provided due to compatibility reasons with previous versions.

1.2. *001.img format

Example: Starting name: TEST145.IMG
Sequence: TEST145.IMG, TEST146.IMG, TEST147.IMG etc.

The default extension is 001 and the user only has to select a file base name. In this case the files are named NAME.001, NAME.002 etc.

When saving a sequence one has to select the starting name. All other file names are derived starting from this file name:

Note: The numbering can have up to 7 digits

2. TIFF sequence format.
There are two ways to save image sequences in TIFF format:

2.1. **Data to TIFF** sequence
Images are saved in 8 or 16 bit TIFF format, depending on the depth of the image buffer. If the image buffer is 8 bit, TIFF will be 8 bit deep, otherwise it will be 16 bit deep.

"Data to TIFF" preserves the measurement data. The saved image data do not depend on the LUT settings, although the LUT settings are saved in the TIFF header and restored from it when re-loading such an image.

2.2. **Display to TIFF** sequence
Images are saved in 8 bit TIFF format. This is a color-palette format. If the LUT is grayscale when saving the TIFF file, the palette contains gray scales, otherwise it contains hued colors.

"Display to TIFF" does not preserve the measurement data. Its purpose is to store pictures which look like the image on the monitor screen. So, the contents of image data depend on the current LUT settings. Use "Disaplay to TIFF" if you want to save images for presentation purposes, but never try to store your measurement data this way!

3. **ASCII** sequence
Images are saved in ASCII format. Note that ASCII format does not preserve any calibration information.

The files created can be read with the **Open** function (however ASCII files can not be read by this program). Depending on the file format you choose, you can either display single images or a whole sequence.

If you execute image processing operations on a sequence all sequence images are treated in parallel. This is true for **Background subtraction** (the background image is taken and is subtracted from all images), **Shading correction**, **Curvature Correction**,**Arithmetic operations** and **Map values by LUT**.

4. **HIS** sequence
All images of a sequence are saved in one single file. This allows to use full performance of your computer system. It is the fastest way to record images on hard disk. You have to use this format if you use the **Fast hard disk** recording mode.
Note: If you want to convert a HIS sequence into another image format you have to load the HIS sequence and save it again after selecting the desired image sequence file format.

Details of sequence mode

Following information may be useful to use the sequence mode most effectively:

The program for sequence mode has been designed to allow fast and flexible image acquisition. However these two targets can not be reached under all operating conditions at the same time. Therefore two submodes of the sequence mode can be distinguished:

A mode optimized for highest speed (Mode S) and a mode optimized for best flexibility (Mode F).

The Mode S is the default mode and is used when **all** of following conditions are true:

- The images are saved to RAM
- No profiles are saved
- Live or Acquire mode is used
- Interval is "full speed" or < 1 second
- No auto corrections are used or "Do auto correction after sequence" is selected

The mode F us used when **one** of following conditions is given:

- Analog or Photon counting mode is used
- No images are saved (neither to RAM not to hard disk)
- Images are saved to hard disk
- Profiles are saved to hard disk
- Fixed interval is used with interval time > 1 second
- Auto corrections are executed directly after image acquisition

Additional remarks:

Wrap during acquisition is only available when Live mode is used.

The image is displayed and the Auto LUT is executed after every sample if either **Always display image during acquisition** is selected or fixed interval with interval time >2 seconds is used or if no images or profiles are saved (neither to RAM nor to hard disk).

Histogram and Profile update is done if fixed interval with interval time > 2 seconds is used.

If fixed interval with interval time > 10 seconds is used the timing information in the image caption (and in the header of the image files) is formatted like hh:mm:ss, using the system standard time. Otherwise it is formatted like xxxxms showing the time passed after acquisition of the first image in milliseconds.

Only if images are stored to hard disk every image status can have its individual information. Only in these cases the sBackString of the UserFunction will be appended to the status string and saved to the image header.

Profile sequences

Profile sequence acquisition

Select **Acquire and store defined profiles** in the Sequence – Data storage dialogue to enable recording of profile sequences. Also a base file name or the name of the first profile within the sequence has to be defined. During sequence acquisition the system adds four digits to the base name: The first digit specifies the profile memory number and the last three or four digits the number of the series. For example a profile name test6001.prf indicates the profile memory number 6 and the first exposure

Before you can start to record a sequence of profiles, you have to get a sample images and define the profiles (see "Acquiring Profiles" on page 162).

Profile sequences are recorded for all profiles for that ROIs are defined.

Then you have to define the timing parameters of an sequence as described in the chapter above. After pressing **Start Acquisition** a series of profile files will be stored.

Profile sequence display

Unless you have just recorded a sequence, you need to load one from disk before you can display it . Use the **Load** function of the profile dialogue in order to open a profile sequence. The system will automatically detect if the selected file is part of a sequence.

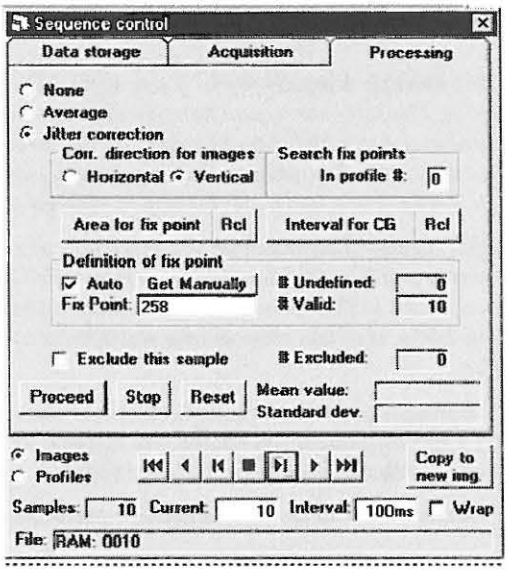
Select **Profiles** in the Sequence control – Acquisition dialogue to display a sequence of profiles.

The way how to use the profile sequence dialogue is analog to the image display.

Processing sequences

It is possible to do some post processing operations with image and profile sequences. Choose the **Processing** tab from the **Sequence control** to display the dialogue for sequence processing. It is possible to

- Average a number of images or profiles
- Do jitter correction



Sequence processing dialogue

Averaging

If you press **Average**, all data (images or profiles) of the current sequence will be averaged. This can be used for creating noise reduced data.

It is possible to exclude some data of the sequence from averaging. This is e.g. useful, if one or several data of the sequence show unwanted contents.

Display the data you want to exclude from averaging and click **exclude this sample** in order to eliminate this data from averaging.

Finally, hit the **Proceed** button.

In case of image data, the result will be displayed in a new image window. In case of profiles, the result will be displayed in the **Profile Display** window.

The result image is always a 16 bit type. All images are averaged, and in the case that the original images are no 16 bit images they are multiplied by an appropriate factor to use the full 16 bit depth without exceeding it. In the case of photon counting images the images are only summed up without averaging. The following formulas are applied to normal and photon counting images:

$$R_N = \frac{\sum I_n * f}{n}, R_{PC} = \sum I_n$$

Where R_N is the result pixel value for normal images, R_{PC} is the result pixel value for photon counting images, I_n is the pixel value of the image n (at the shifted location), f is a factor indicated below and n is the number of samples.

Data type of the original images	f
16 bit	1
14 bit	2
12 bit	8
10 bit	32
8 bit	128

Jitter Correction

This function is mainly useful if you work with a streak camera in single sweep mode. The jitter correction function allows to sum up images or profiles containing signal which may be shifted on the time axis due to trigger jitter without losing temporal resolution. This is especially useful if the signal level for a single sweep is low and a single image would have too low statistics.

After a general introduction you learn how to make the data set-up for jitter correction and how to determine fix points, which are necessary to perform correction later on. Then you learn how to make correction with images and profiles. The last part of this chapter tells you about several limitations of jitter correction.

The images or profiles on the hard disk are individual files which are linked only by a special naming convention (see the chapter "Sequence naming convention"). Both naming conventions are supported. (e.g. test001.img, test.001)

There are three steps which should be performed to process jitter correction:

- Perform data set-up
- Determine the fix points
- Overlay the images or profiles

The following three chapters "Data Set-up", "Determining Fix Points" and "Overlay the Images or Profiles" first describe generally which steps should be executed to perform jitter correction. The chapters "Performing Jitter Correction with Images" and "Performing Jitter Correction with Profiles" then describe what should be done practically when performing jitter correction with images or profiles. The chapter "Problems and Limitations" refers to special issues.

Data Set-up

First of all you have to select the data which should be processed by the jitter correction. There are three different types of data which could be selected:

One image or a set of profiles derived from one image is called one sample. The number `YYY` therefore represents the number of the sample.

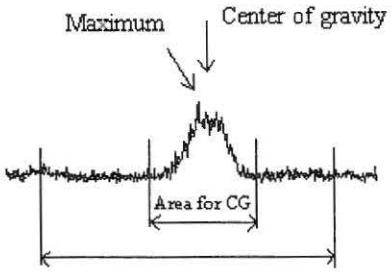
For data set-up you have to select an area for the automatic detection of the fix point and an interval for a centre of gravity detection which is used to precisely calculate the fix point. If you analyse images you additionally have to tell the system which direction should be used for jitter correction (either horizontal or vertical). If you analyse profiles you additionally have to select the memory number containing profiles which should be used for the fix point definition, as several profiles can be processed in parallel.

Determining Fix Points

The jitter correction function automatically determines fix points whenever a sample is loaded the first time. The user can then modify the fix point if he wishes. The automatic fix point determination works as follows:

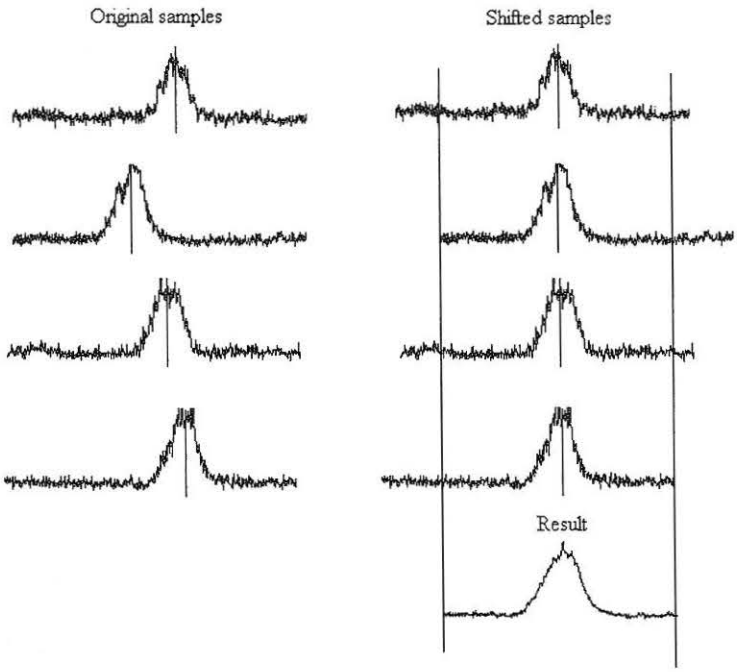
In case of images it first extracts a profile from the image at the area which has been defined during data set-up with the push-button **Area for fix point** along the full length of the time axis. In the case of profiles it just takes the profile.

Then it searches for the global maximum along the profile. Then it calculates the centre of gravity around the maximum in a region which width has been defined by the push-button **Interval for CG**. Then it checks whether this fix point is within the area for fix point detection. If it is outside this sample is excluded automatically from further analysis.



Overlay the Images or Profiles

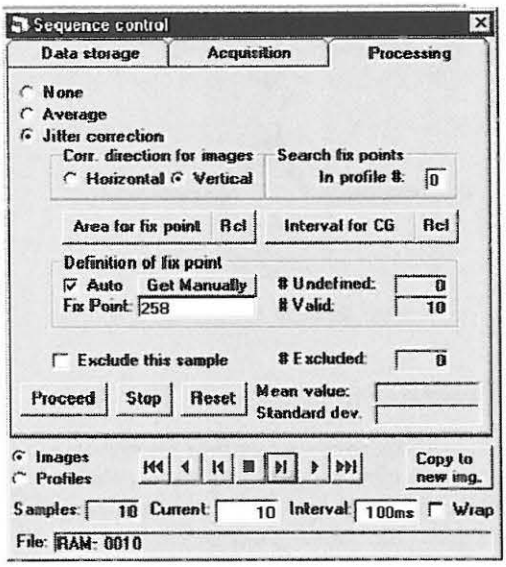
When all fix points are defined the system will shift all samples in a way that the fix points of all samples will come to the same place and then overlay (add up) all samples. Only portions of the samples will be used which are present in **all** samples. The resulting sample will therefore be shrinked along the time axis.



Shifting and overlaying samples

Performing Jitter Correction with Images

It is assumed that an image sequence is currently present. Click **Images** in the lower part of the dialogue box.



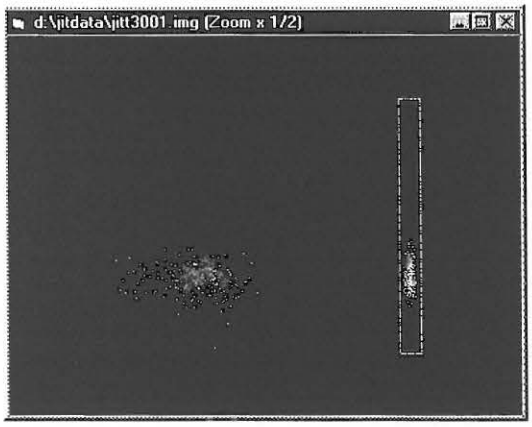
Jitter correction dialogue box

Use the Area ROI tool.

Select the area where the system should look for the fix point. This is done by selecting a rectangular area of interest (see "Selecting Regions of Interest (ROIs)" on page 41) and pressing the push-button **Area for fix point**.

Then you have to select the interval for centre of gravity detection by selecting another rectangular area of interest and pressing the push-button **Interval for CG**. Only the width of the interval is used, its position does not matter.

These two areas are used later on when the fix point is determined automatically by the system. The system extracts a profile from the area indicated by **Area for fix point**, but extended to the full length of the time axis. Then the system looks for the maximum and calculates the centre of gravity in the area defined by **Interval for CG** centred around the maximum. This is done to minimise the influence of any remaining offset in the image. If the centre of gravity does not lay within the area for fix point this sample will be excluded in the process.



Selecting the area for fix point for images

Selecting the area for centre of gravity detection for images

Additionally you have to tell the system which direction should be the correction direction (i.e. which axis is the time axis) by selecting one of the radio buttons **Hor.** or **Vert.** in the frame **Corr. direction for images**. The images are then shifted along this direction to fit the fix points.

Now you can step through all samples and you will see the fix point which the system has found. You can step through all samples by using the push-buttons in the lower center part of the dialogue: where "|<<" means first sample, ">>|" means last sample, "|<" means step backward and ">|" means step forward. You also can type in the sample number in the text box **Current**.

You can also play the samples automatically with a specified interval time. The interval time can be entered into the text box beside **Interval** where also fractions of a second can be selected. Pressing stops the play action.

The Point ROI tool

Once a new sample is selected the system calculates and displays the fix point and its numerical value. The display of the fix point is done by a horizontal (or vertical) line which has the width of the area for fix point determination. If you want to exclude this sample manually select **Exclude this sample**. If you want to enter another fix point manually select a point ROI and select the location where you want to fix the fix point manually. Then press the push-button **Get manually**. **Auto** will automatically be deselected in this case.

Reset will reset all fix points and exclude selections.

When all fix points are defined press **Proceed** to start the process of shifting and overlaying the images. All images are loaded, displayed and processed.

The result image is always a 16 bit type. All images are averaged, and in the case that the original images are no 16 bit images they are multiplied by an appropriate factor to use the full 16 bit depth without exceeding it. In the case of photon counting images the images are only summed up without averaging. The following formulas are applied to normal and photon counting images:

$$R_N = \frac{\sum I_n * f}{n}, R_{PC} = \sum I_n$$

Where R_N is the result pixel value for normal images, R_{PC} is the result pixel value for photon counting images, I_n is the pixel value of the image n (at the shifted location), f is a factor indicated below and n is the number of samples.

Data type of the original images	f
16 bit	1
14 bit	2

12 bit	8
10 bit	32
8 bit	128

When the jitter correction process has ended a statistical analysis is done on all valid fix points yielding their mean value and the standard deviation.

Image 1

Image 2

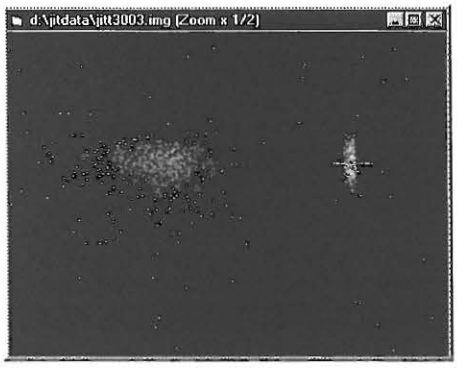


Image 3

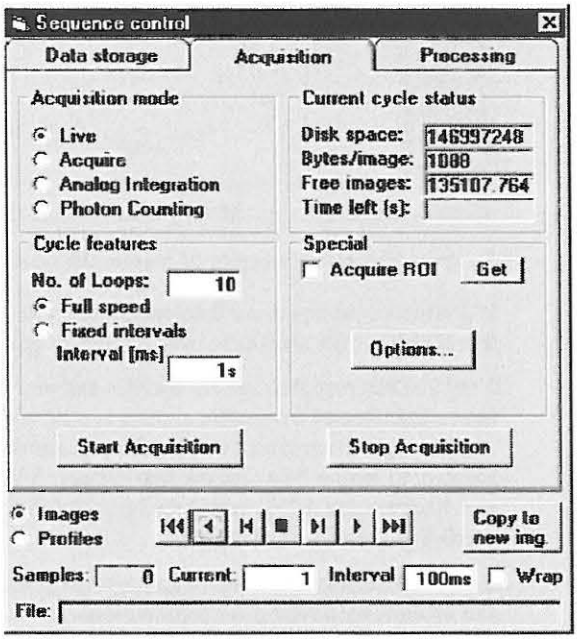
Image 4

Result

Image overlaid by the jitter correction function. In this case a special marker pulse is used to determine the fix point (located on the right side of the image). The pulse which should be examined is located on the left side. The result image is smaller than the original images.

Performing Jitter Correction with Profiles

It is assumed that a profile sequence is currently present. Click **Profiles** in the lower part of the dialogue box to process profiles.



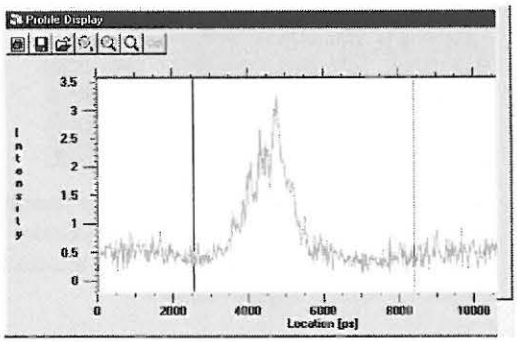
Sequence processing dialogue box

Then select the area where the system should look for the fix point. This is done by placing the lower and upper cursor within the profile display to the desired values and press **Area for fix point**.

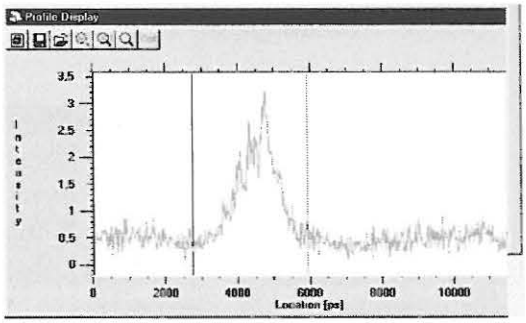
Then you have to select the interval for centre of gravity detection by again placing the lower and upper cursor to the desired values and pressing the push-button **Interval for CG**. Only the width of the interval is used, its position does not matter.

The **Rcl** buttons recalls these two areas.

These two areas are used later on when the fix point is determined automatically by the system. To determine the fix point the system looks for the maximum within the profile and calculates the centre of gravity in the area defined by **Interval for CG** centred around the maximum. This is done to minimise the influence of any remaining offset in the image. If the centre is not within the area for fix point this sample will be excluded in the process.



Selecting the area for fix point for profiles



Selecting the area for centre of gravity detection for profiles

If a sample contains more then one profile you additionally have to tell the system which profile should be used for the fix point determination.

Now you can step through all samples and you will see the fix point the system has found. One of the profile cursors is used to indicate the fix point. You can step through all samples by using the push-buttons in the lower part of the dialogue box: where "|<<" means first sample, ">>|" means last sample, "|<" means step backward and ">|" means step forward. You also can type in the sample number in the text box **Current**.

You can also play the samples automatically with a specified interval time. This can be done by pushing the push-buttons "**<-**" backward, "**->**" forward. The interval time can be entered into the text box besides **Interval** where also fractions of a second can be selected. Pressing stops the play action.

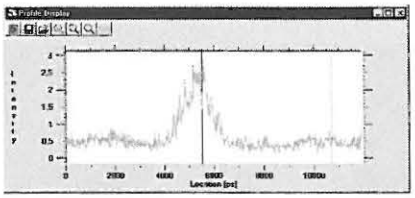
The Point ROI tool

Once a new sample is selected the system calculates and displays the fix point and its numerical value. If you want to exclude this sample manually select **Exclude this sample**. If you want to enter another fix point manually mover the cursor to the location where you want to fix the fix point manually. Then press the push-button **Get manually**. **Auto** will automatically be deselected in this case.

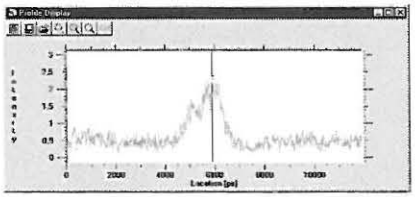
Reset will reset all fix points and excluded selections.

When all fix points are defined press **Proceed** to start the process of shifting and overlaying the profiles. All profiles are loaded, displayed and processed . The result profiles will be displayed in the profile display window. Normal profiles are averaged and profiles which are derived from photon counting images are only summed up to preserve counting statistics.

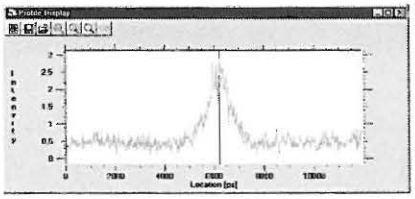
When the jitter correction process has ended a statistical analysis is done on all valid fix points yielding their mean value and the standard deviation.



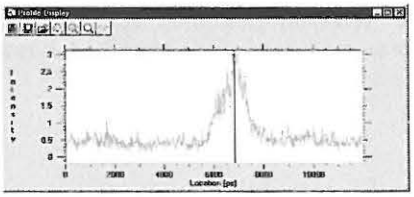
Profile 1



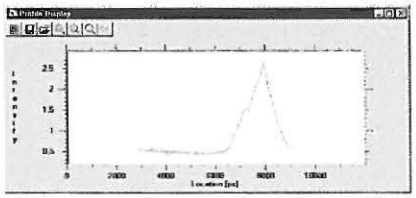
Profile 2



Profile 3



Profile 4 ....



Result (50 profiles were analyzed in this case)

Profiles overlaid by the jitter correction function.

Problems and Limitations

There are two cases which can disturb the process of jitter correction considerably:

1.) The data contain a large offset

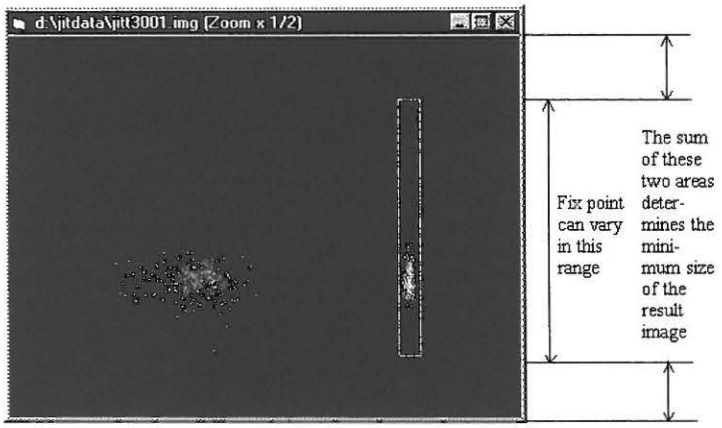
2.) Each sample contains only very few photons

In the case 1.) the offset can cause a considerable deviation of the calculated fix point. Normally it is strongly recommended to perform background subtraction correctly. If you cannot use data without background you must carefully check the resulting fix points and modify them manually if you find deviations.

It is recommended that you use an **Interval for CG** as small as possible.

In the case 2.) the resulting pulses may be too narrow if there are too few photons. This is the limit of the method and if you do not have additional information about the real fix point you will not get correct results (just imagine what would happen if there were only one photon in every sample). In such cases you must try to find a stronger signal for fix point determination.

The larger the variation of the fix point is (i.e. the larger the jitter of the data), the smaller will be the result image. The minimum size of the result is the area which was **not** be selected by the command **Area for fix point**.



Transient Absorption

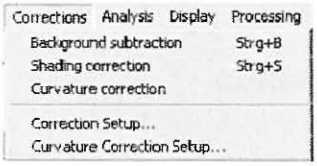
The entry "Transient Absorption" appears in the menu if the Transient absorption software module has been purchased. It is an optional add-on for the HPD-TA. For usage instructions please refer to its separate manual.

Corrections

Overview

In the corrections menu you find commands which are related to image data corrections.

There are following commands:
Background Subtraction, Shading Correction, Curvature Correction, Curvature Correction Setup.. , Defect Pixel Correction Setup and **Correction Setup.**



Background Subtraction

 *Make Background subtraction*

The **Background subtraction** command subtracts a background image from the current image in the frame buffer. How this is done is determined by the settings in the correction set-up dialogue box (see chapter "Background Subtraction" on page 152 for details).

If you want to automatically subtract background after each acquisition, you can select the **Auto Backsub** item in the **Options** menu (see "Auto Backsub" on page 88).

Shading Correction

 *Make Shading correction*

The **Shading Correction** command corrects intensity non-uniformities of an image in the frame buffer. How this is done is determined by the settings in the correction set-up dialogue box (see chapter "Shading Correction" on page 154 for details).

If you want to automatically correct shading after each acquisition, you can select the **Auto Shading** item in the **Options** menu (see "Auto Shading" on page 89).

Curvature Correction

The Curvature Correction command corrects geometric distortion of an image in the frame-buffer. How this is done is determined by the settings in the Curvature correction set-up. (see section "Curvature Correction Set-up" on page 157 for details).

If you want to make curvature correction automatically after each acquisition, you can select the **Auto Curvature** item in the **Options** menu (see "Auto Curvature" on page 89).

Defect Pixel Correction Setup

A special function has been implemented into HiPic in order to correct defective pixels of the sensor.

In a first step (Setup), bad pixels, lines or columns of the camera are detected. The co-ordinates of the bad pixels are then stored in a special data file.

During normal operation with the sensor the defective pixels are then corrected if the pixel correction function is enabled.

The intensity value of an defective pixel, line or column is calculated by the intensity values of the neighbouring pixel.

Correction setup

The setup has to be made to find and store a defective pixel mask of the actual detector. This procedure has to be done just once for a detector. In later sessions the stored pixel mask data will be used for correction.

Step 1

Acquire and store images with hot and/or dead pixel:

The recommended procedure is to acquire an image with a homogeneous illumination (only small grey level variation) at an average pixel intensity of 50% of the maximum value. Whenever possible it is recommended to acquire the image in Image Accumulation mode with 8 or 16 images integration. Use the camera binning mode settings and exposure time settings which you will typically use for routine operation.

Save the image on your hard disk.

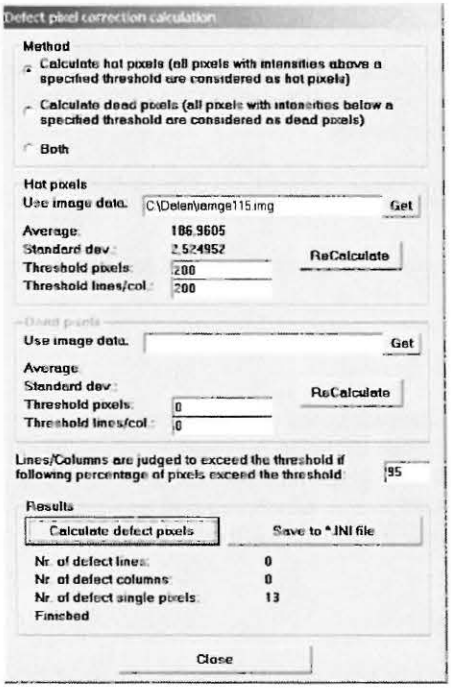
This image will be further used to calculate dead (pixel which have significantly reduced sensitivity) and hot pixel (which have a high dark current).

If you will use the detector with several binning modes, you have to record one image of any binning mode.

If you are planning to correct for hot pixel only, you may acquire an image without illuminating the detector (dark image).

You can also acquire an dark image and an image with illuminated detector and later use the dark image for hot pixel correction and the illuminated image for dead pixel correction.

Step 2



Defect Pixel Correction Set-up dialogue

Select ***Defective Pixel Correction Setup*** from the ***Correction*** menu to open the setup dialog.

Step 3

At first you have the to decide which method you want to apply. Select **Calculate hot pixels...** if you want to correct the pixels which have a higher dark signal than average pixel. Select **Calculate dead pixels...** if you want to correct the pixels which have a lower sensitivity than average pixel. Select **Both** if you want to correct hot and dead pixel (this is usually recommended).

Step 4

Select the defective pixel image in the correction setup dialog. If you have acquired one image for dark and hot pixel correction, please select the same file name in the "Use image data" entry of the hot and dead pixel section. If you have acquired different images for hot and dead pixel, please select the corresponding images in the sections.

Step 5

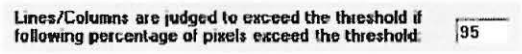
The system will suggest a reasonable threshold for discriminating normal pixel from bad pixel. The threshold is an intensity value which is related to the average intensity value and the standard discrimination of the reference image. The value suggested by the software can be manually changed if the correction map is not reasonable upon customers considerations.

Press **ReCalculate** in the Hot pixel and/or Dark pixel section to calculate the suggested threshold value.

A separate value for singular pixel and lines/columns can be selected. These values may have to be chosen upon the features of individual sensors. If it turns

out that the recommended values do not lead to satisfying results manual change is recommended. We can not give general recommendations for optimising the threshold. User has to change and try.

An additional threshold is applied for lines/columns. Lines/columns are considered as defective if the percentage of defective pixel in a line or raw exceeds the value defined in:



Usually a value greater than 80% leads to reasonable results.

Step 6

After completing the threshold settings you have to click **Calculate defective pixel**. Then the defective pixel mask will be calculated. You can see the number of defective pixels and lines/columns indicated below the Calculate defective pixel button. The calculation will take a few seconds. As soon as „finished" is displayed the calculation has ended.

Step 7

Finally you have to save the defective pixel mask in an specific file (*.ini file).

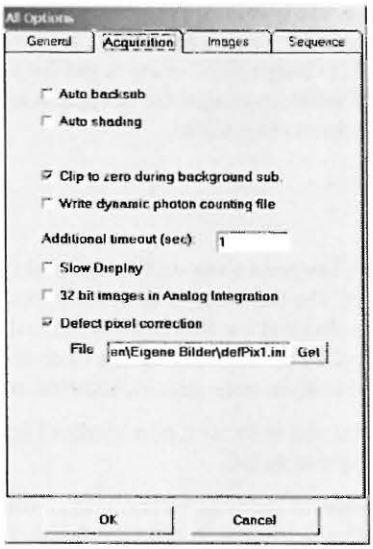
Press Save to *.ini file and then select file name and directory.

Note: When you generate different pixel masks with different binning factors of the same detector you have to choose the same file for all pixel masks. The data are then all collected in one *.ini file.

Enabling bad pixel correction

After generating a defect pixel mask file (if not already supplied with the detector system) you can do defect pixel correction for the images which you acquire.

Open the Options dialog of the Setup menu.



Set-up Options dialogue

Then click on the Acquisition tab.

Check the **Defect pixel correction** box and define the file location and file name of your defective pixel mask file. Do this by pressing the **Get** button and selecting the proper file in the file open dialogue.

Finally you can close the dialogue. The setting will be kept for the next session with HiPic.

Now bad pixel correction will be performed for all images.

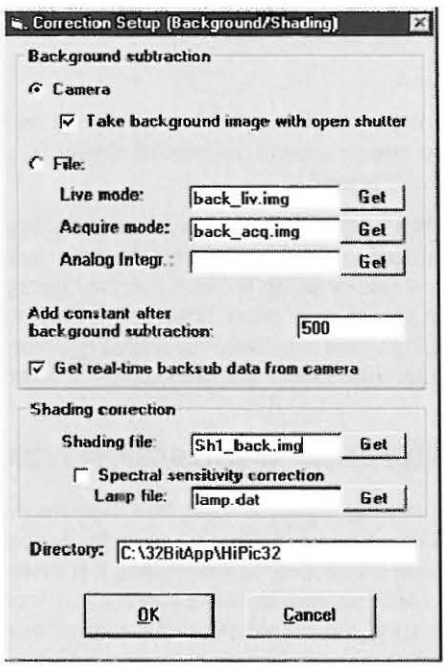
Correction Set-up

In the Correction Setup dialogue box the behaviour of the background subtraction and shading correction can be set.

Choose **Correction Setup...** from the **Corrections** menu to display the Correction Setup dialogue box.

This chapter is split up into following sections: First Background subtraction is explained in general, in the next section you learn how to set-up the subtraction from camera image method. In the third part subtraction from file is described. In the section "Details about Background Subtraction" you can read technical details of this correction method. The next part refers to the handling of constants for subtraction.

The following chapters refer to shading correction. After a short introduction you learn how to set-up shading correction. In the section "Algorithm of Shading Correction" you can read technical details of this correction method



Correction Setup dialogue box

The controls within the frame **Background subtraction** determine the behaviour of the background subtraction. The control within the frame **Shading correction** determine the behaviour of the shading correction.

Background Subtraction

The Background subtraction function allows you to subtract the camera dark current from an acquired image. The function can also be used to subtract offset signals of other origin such as undesired background light or stray light.

Background subtraction can be performed either "from camera" or "from file".

Background Subtraction from Camera

When the option **Camera** is selected a new background image is acquired after each image acquisition and then subtracted from the acquired image. This means, the background image is taken after the data acquisition.

The background image is automatically acquired with the same parameters (such as exposure time and camera gain) as the acquired image. This method is easy to use and convenient if the exposure time is not too long. (In case of long exposure times you may wish to use the "from file" method instead.).

Following description refers to a configuration where a C4880 type camera except C4880-80 and C4880-40 is used.

The check box **Don't prompt the user before backgr. sub** defines whether the C4880 shutter will be closed or opened during background acquisition. In most cases you will prefer that the shutter is closed automatically during background acquisition since this is the most convenient way. However, if you want to subtract also background light which has an external origin (such as stray light), you could disable this automatic shutter control by selecting the check box.

Following description refers to a configuration where a analog video camera or another camera without mechanical shutter (e.g. C3077, C4880-80, C4880-40 or C4742-95) is used.

If **Don't prompt the user before backgr. sub** is not selected the user is prompted to close any external shutter or switch off the illumination light or take a similar action to avoid that the light signal comes to the camera during background acquisition. If the option **Don't prompt the user before backgr. sub** is selected the user is **not** prompted to take any such action and Background subtraction immediately proceeds.

Background Subtraction from File

In case of long exposure times, the "from camera" method may become inconvenient since it would take the same time to acquire the background image after every data acquisition. In these cases, it is preferable to save a background image to hard disk once and load it every time it is needed. Of course, this makes sense only if you can assume that the same background image can be used for a series of data acquisitions (i.e. the acquisition conditions, like exposure time, will not change considerably.)

Note: When using the "from file" method the user must take care by himself that the background image contains suitable background data.

To perform background subtraction "from file" select the option **File**. As the readout parameters can be different for the different acquisition modes you can specify different files for the different acquisition modes. Press **Get** to open a file selection dialogue and select the desired file.

Save a background image

To obtain a valid background image you simply take an image under background light conditions with the desired image parameters which you want to use for your measurement, e.g. correct exposure time, scan area, binning factor etc. Save this image by using the **Save as...** command (see "Save As .." on page 50).

Warnings

If the file which you defined as background image file (see below) does not fit to your measurement conditions (e.g. if the binning factors are different) you get an warning message when executing **Background subtraction** (see "Background Subtraction" on page 147) and you are prompted to prepare a suitable file and try background subtraction again.

In some case, e.g. if temperature conditions or exposure conditions are very much different for the image in the background image file and in the frame buffer, you will get a warning message before the subtraction is performed and you can decide whether to proceed anyway or you want to prepare another background image. This should be just a hint from the program that the data may not be well suitable, but -as said above- the choice is yours.

Note: Background subtraction "from file" always subtracts pixels which have the same locations on the frame buffer one by one. Images which serve as background images should not have been shifted to another location (e.g. by loading it to a different location and saving it), and conditions like binning factors and optical black parameters should not differ.

Details About Background Subtraction

Note: This chapter contains information about how the background subtraction process works.

If the original image or parts of it and the background image have similar intensities and/or if the original image is completely dark on some areas, negative intensity values may result in several pixels after background subtraction. There are, however, some reasons not to allow negative values in the image:

- Negative intensity values often do not have a physical meaning (there is no "negative light intensity").
- Image processing programs often cannot interpret negative values correctly.

Considering all these arguments **HPD-TA** handles the question of negative values as follows:

The user can select if the images should be clipped to zero or not during background subtraction by selecting or deselecting the checkbox **Clip to zero during background sub.** in the section **General** of the **Setup – Options** menu. 8 bit images are always clipped to zero.

Constant

You can add a **constant** during background subtraction process. This is especially useful when normal acquisition modes are used and negative values would be clipped to zero. By adding a constant you will see the image noise correctly even in dark areas. To add a constant during background subtraction processing you simply enter the desired offset value in the edit box **Add constant after background subtraction**.

If you add a positive constant it may happen that the current bit range is exceeded. In this case the values are clipped to the maximum possible value within the bit range (e.g. 255 in 8 bit images, 1023 in 10 bit images and 4095 in 12 bit images). Therefore it is recommended to choose a constant not higher than necessary (the amount of noise is normally only a few counts). The constant is used for "from camera" type subtraction as well as for background subtraction "from file".

Get real-time backsub data from camera

This function is related to the realtime background subtraction of the **Live** mode. There are two ways of getting the background image for the realtime background subtraction (see also „Basics of the Photon Counting Mode“ on page 96):

- **Get real-time backsub data from camera** is checked:
  Acquire a new background image in Live mode with your camera by clicking the button **Get BG data** in the **Live** menu.
- **Get realtime backsub data from camera** is unchecked:
  Use a image from file as background image (use this function if you have stored a background image on your harddisk before). After you press the **Get BG data** in the **Live** dialogue a file selection dialogue will be opened. Select the file which you want to use as background image for realtime background subtraction.

Shading Correction

Shading correction is a method to flatten a spatially non-uniform sensitivity of the complete imaging system.

Due to several reasons an imaging system can have a non-uniform sensitivity at different locations. The reasons may be uneven illumination, lens shading (vignetting), different sensitivity of the CCD pixels. If an image intensifier is used, the image intensifier may have a spatially varying light amplification.

For streak cameras there are some special reasons which lead to such varying sensitivity: The input slit width may vary slightly (especially for small slit widths). The MCP of the streak tube may have varying amplification, there are two optics (input and output optics) which introduce some shading and the streak sweep may be slightly non-linear which leads to a slowly varying signal amplitude along the time axis.

All these effects can be compensated by a multiplicative correction which we -by convention - call shading correction.

Get a Shading Reference Image

Sometimes, especially if one has to work under low light level conditions it may be very difficult or even impossible to obtain a shading reference image. In this case, shading correction can not be applied.

To be able to perform shading correction one must first acquire a shading reference image. A shading reference image is taken from a scene which is completely flat (homogenous illumination) within the field of view.

First, acquire this image by the imaging system (see section “Acquisition Menu" on page 94), then perform background subtraction on this image (see "Background Subtraction" on page 152). Then you have to store the reference image using the **Save as...** command (see "Save As .." on page 50). Pay attention that the shading reference image should not have an intensity value of 0 at any pixel.

Declare an Image as Shading Reference Image

In order to declare the shading reference image which you acquired as described above as the shading reference image to the system, you have to press **Get** next to the text box **Shading file** of the correction set-up window. A dialogue for file selection will be opened. Please refer to the chapter "Shading Correction" on page 147 for to learn how to actually perform shading correction.

Algorithm of Shading Correction

During shading correction the following calculation is performed:

$$C_{(x,y)} = \frac{D_{(x,y)} * K}{S_{(x,y)}}$$

C: Corrected image data (output image)
D: Uncorrected image data (input image)
K: Constant
S: Shading reference image

The calculation is performed with long integer arithmetic.

Constant K

The constant **K** can be specified by the user. At locations where $K = S_{(x,y)}$ the data will not be changed, at locations where $S_{(x,y)} < K$ the image intensity will be enhanced after shading correction, and at locations where $S_{(x,y)} > K$ the image intensity will be reduced after shading correction. The upper LUT cursor (see also chapter "LUT Tool" on page 36) of the shading reference image is used to specify the constant K.

When setting the LUT values by the AUTO LUT function (see "Auto LUT" on page 90) the upper LUT cursor will be set around the maximum value of the shading reference image. Normally shading data have a maximum intensity at the centre of the image and will slightly decrease at the image borders. Thus shading correction with a shading reference image where the LUT cursors have been set by the AUTO LUT function will keep the image intensity in the centre and enhance it at the borders. In almost every case this is the most convenient and easiest way of specifying the constant K.

Shading correction automatically accounts for chip type, frame-buffer type and binning factor, thus you can compensate an image which has been taken from the camera in normal mode with an image taken in 2 x 2 binning mode (see the section on "Basic operations" for details). Generally speaking the correction is always done with the pixels from the shading reference image which correspond to the same location **on chip**.

The normal clipping is performed when the data exceed the current bit range. When zero is found in the shading reference image the corresponding pixel is not corrected (Shading reference images should not have zero values as a contents). The shading data should be background subtracted and should **not** be shading corrected itself. Otherwise an error message will be issued and the shading correction is not performed.

Spectral Sensitivity correction

Spectral Sensitivity correction is a more complex way of shading correction, especially designed for ***correction of the spectral intensity characteristic*** *of a spectrometer and the camera detector for quantitative intensity analysis. While*

standard shading correction assumes that the light source used for shading image acquisition (in combination with a spectrograph) has a flat spectrum, the spectral sensitivity correction takes an uneven spectral emission of the light source into account. The spectral correction works along the horizontal axis of streak images.

Before you can use the spectral sensitivity correction, you have to prepare a set of data (a table), which contains information about wavelength and correction factor of your light source. We call this function $L(\lambda_n)$.

For example you may use information about the absolute light emission characteristic of your light source supplied by the lamp manufacturer as a basis for this table. Such data is normally available for calibration lamps.

If we assume that the spectral range which you will use for analysis ranges from λ_{min} to λ_{max}, you have to make sure that the table of correction data $L(\lambda_n)$ where n= 1 to m
follows following rules:

$\lambda_1 \leq \lambda_{min}$, $\lambda_n < \lambda_{n+}$, $\lambda_m \leq \lambda_{max}$.

The table must have the format (ASCII format)

...
λ_n, $L(\lambda_n)$
λ_{n+1}, $L(\lambda_{n+1})$
...

Algorithm of Spectral Sensitivity Correction

During spectral sensitivity correction the following calculation is performed:

$$C_{(x,y)} = \frac{D_{(x,y)} * K * L(\lambda)}{S_{(x,y)} * K_2}$$

C: Corrected image data (output image)
D: Uncorrected image data (input image)
K: Constant
K_2: Constant
S: Shading reference image
$L(\lambda)$: Lamp correction function

The calculation is performed with long integer arithmetic.

This means that when shading correction is performed, not only the system shading is corrected but also the dependence of emitted light intensity versus wavelength of your lamp is considered.

The proper correction factors are automatically calculated from the user defined table, in accordance with the actual spectrometer setting and scaling. Also K_2 will be automatically calculated by the program.

This function works only when streak scaling method is used (see "Scaling Method: Streak Scaling" on page 70).

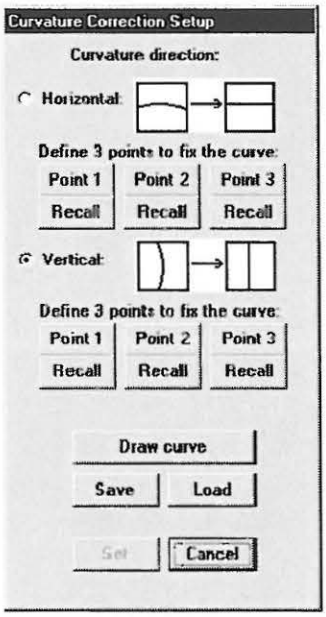
Before you enable the spectral sensitivity correction function you have to select the calibration file (lamp file) which you want to use by clicking the **Get** button and choosing the desired file. If it is enabled, the correction will be carried out by the **Shading Correction** command.

Curvature Correction Set-up

__Note:__ This chapter describes a function which is usually needed if you use a streak camera with synchroscan mode.

In synchronous blanking mode of synchroscan operation the deflection of streak sweep is not completely straight, but elliptic. This results in a geometric distortion of the streak image in sweep direction. Curvature Correction corrects the distortion by compensating it with a parabolic correction curve.

Choose **Curvature Correction** from the **Setup** menu to display the Curvature Correction Setup dialogue box.



Curvature Correction set-up window

The Curvature Correction can be performed either in horizontal or in vertical direction. Choose the **Horizontal** method, if streak sweep is horizontal or **Vertical**, if sweep is vertical.

The geometric correction is done by using a parabolic correction curve. By specifying three reference points the parameters of the parabola can be specified.

First, you have to acquire a streak image with a signal which shows the curvature distortion. Use this image to define the correction parabola.

To enter the location of the reference points click the push-button **Point 1** first and select an point on the left or upper position of the distorted curve and click the left mouse button. Repeat this with **Point 2** and **Point 3**. Point 2 should be in the centre and Point 3 at the lower or right side of the image.

Click **Recall** in order to resume the previous data.

When **Draw Curve** is clicked a correction curve is calculated and displayed, which interpolates the three selected points. You can re-adjust some of the selected points if the curve does not yet fit correctly to your distortion. Click at the corresponding **Point** button, readjust the reference point and draw it again by pressing **Draw Curve**. If you are satisfied with the curve click **Set.** The curvature data are stored in the system and will be used for curvature correction (see "Curvature Correction" on page 148).

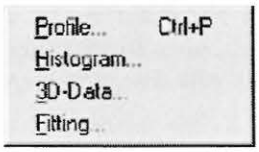
Save a correction setup by clicking the **Save** button. Load a previously saved correction set by clicking the **Load** button and selecting the desired file.

Analysis Menu

Overview

*In the menu **Analysis** functions for quantitative image analysis are available.*

The **Analysis** menu includes the items **Profile, Histogram** and **3D Data**.



Analysis menu

Note: For the HPD-TA an optional TA-Fit module is available which will be enabled by the proper hardware lock. If this option is enabled the additional command **Fitting** will appear.

Profile

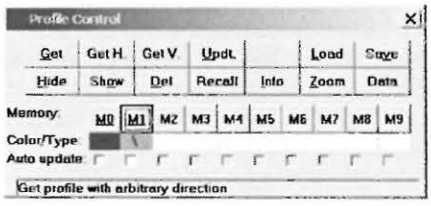
Profile Analysis extracts one-dimensional intensity data from the image along user-defined positions, attaches scaling information and calculates and displays various information about these data.

In the following eight sections you learn how to use the profile analysis tools. First you get general information about the profile tools, followed by a detailed description of the profile control and profile display window. Then you learn how to acquire and display profiles, how to attach scaling to the profiles and how to make a more detailed analysis. Finally you get information about how to handle profile data and how to export them to other programs.

General Information on Profile Analysis

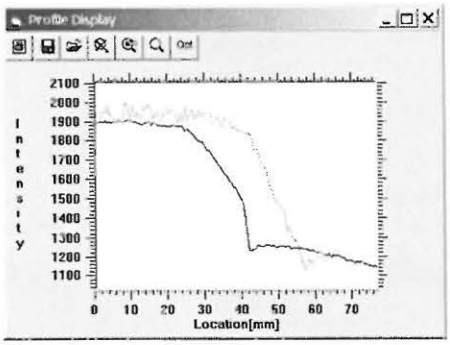
Profile tool

Choose **Profile** from the **Analysis** menu to display the Profile Control and the Profile Display dialogue boxes.



Profile control dialogue box

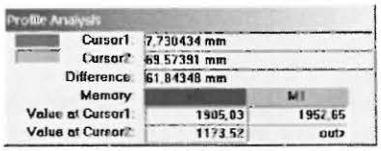
The **Profile Control** dialogue box offers a variety of controls to acquire, display and handle profiles.



Profile display dialogue box

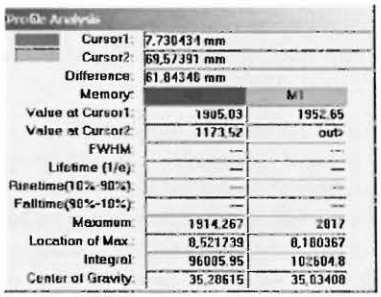
The **Profile Display** window is used to display the profiles. It can be freely resized by the user. A toolbar on top of the **Profile Display** dialogue box offers a variety of display and analysis options.

When the option **Analysis** on the **Profile Display** dialogue box (see below) is selected, the **Profile Analysis** dialogue box appears on the screen in its standard size.



Standard type of the profile analysis dialogue box

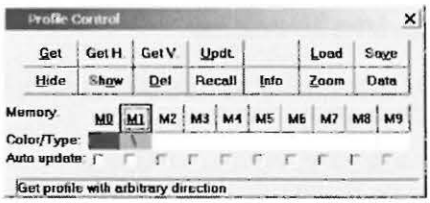
If the option **Detailed analysis** is additionally selected the **Profile Analysis** dialogue box becomes larger and displays several additional analytical data.



Large type of the profile analysis dialogue box

The Profile Control

The **Profile Control** dialogue box is designed in the sense that you first select the desired action (command button) and then the desired memory the action should work on. The last command remains active unless another command button is pressed. For example if you want to delete several profiles it is sufficient to click the **Del** push-button once and then the memory buttons whose profiles you want to delete.



Profile control dialogue box

The **Profile Control** window contains the following parts:

- A series of command buttons on the top of the window.
- 10 memory buttons
- 10 small fields below the memory buttons displaying the colour and the type of the profile (these fields are invisible if the memory is empty)
- 10 check boxes to specify the **Auto update** function
- A text box displaying messages such as a brief description of the currently selected command or an error message

The command buttons activate the following commands:

Get Acquires a profile with arbitrary starting and ending points (requires a line ROI)

GetH Acquires a horizontal integrated profile (requires a rectangular ROI)

GetV Acquires a vertical integrated profile (requires a rectangular ROI)

Updt Updates the profile from the current image (at the same position and direction).

Load Loads a profile from disk into memory. If the profile is a part of a profile sequence the sequence will be loaded starting with the file you selected (see also "Profile sequence display" on page 136)

Save Saves a profile from memory to disk. If the profile is acquired from a image sequence, profile data for all images of the sequence will be saved.

Hide Hides a profile. It disappears from the **Profile Display** window.

Show Shows a profile which previously has been hidden.

Del. Deletes a profile from memory (Caution: this command is irreversible).

Recall Shows the profile sampling window on the current image and displays its co-ordinates in pixels and scaled units in the message field. The selected ROI becomes the current ROI. Its parameter can be changed now (e.g. using the ROI info tool).

Info Shows the **Profile Info** window, which contains the full information about the profile and the parent image

Zoom Adjusts the scale of the **Profile Display** window so that the selected profile will best fit into it.

Data Displays the content of a profile memory in a text box. This can be used for Clipboard and DDE links.

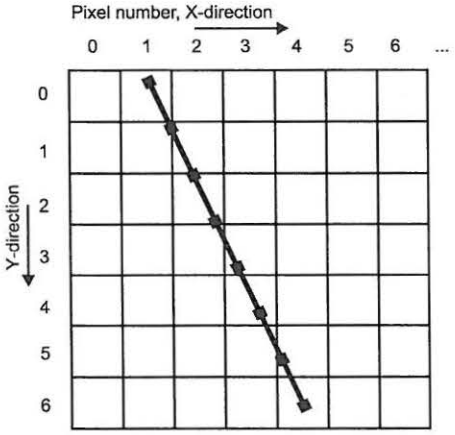
Acquiring Profiles

There are three types of profiles: **Line** profiles, **Integrated Horizontal** profiles and **Integrated Vertical** profiles.

Before you acquire profiles, you may want to assign scales to the X-and Y-axis of the image. Please refer to the chapter "Scaling Set-up " *on page 63 for details about scaling set-up.*

Line ROI tool

When you want to get a **Line** profile select a line-type ROI. See details on the methods for selection of areas of interest in the chapters "Selecting Regions of Interest (ROIs)" on page 41). Press **Get** and the memory button where you want to store the profile. The profile values are sampled along the line as described in the following drawing.



Line profile
Starting point 1,0
End point 4,6

Sampling points:
1,0
1,1
2,2
2,2
3,3
3,4
4,5
4,6

Sampling pixel data along a specified line

The profile is generated by sampling pixel data along the line with at a step width of one pixel. When square scaling (or free scaling with linear scaling in both direction with the same unit) is selected (see "Scaling Method: Free Scaling") the measured distance will be always correct, independent of the orientation of the sampling line.

Note: As a side effect of this sampling technique the value of one image pixel may appear twice in two adjacent profile channels. The method of getting **Line** profiles is especially useful for imaging applications with image sensors having square or non-square pixels.

Integrated Horizontal profiles and **Integrated Vertical** profiles are sampled along the sensor axis either horizontally or vertically.

Area ROI tool

When you want to get a **integrated** profile select a rectangular ROI. See details on the selection of area of interests in the chapter "Selecting Regions of Interest (ROIs)" on page 41.

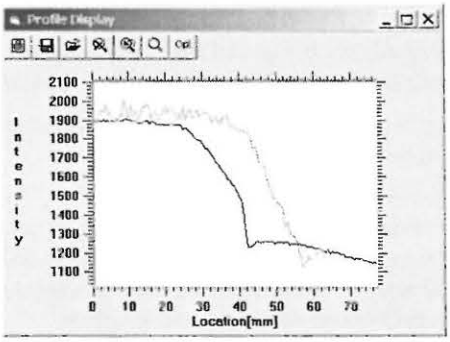
To get either of both profile types press the **GetH** or **GetV** command button and click to the memory button where to store the profile. Depending on the type of profile (horizontal or vertical) a profile is extracted from the image within the specified window. The pixel intensities are averaged (integrated and normalised by the sampling window width) along the direction perpendicular to the profile direction. Since the values are averaged they will be independent of the width of the profile sampling window and fractional pixel intensities may occur with integrated profiles.

When there is already a profile in the specified memory the previously selected profile sampling window is displayed as default. If you select the **Updt** command you automatically get the same profile type as it has been in the memory before with the previously selected profile sampling window, but the data are recalculated from the current image (which may have changed).

When the **Auto update** checkbox is clicked for an already existing profile the profile is automatically updated when the image data have changed. This function is triggered for example by image acquisition, by dark subtraction, by loading an image from disk, and so on. This checkbox has to be clicked if the profile shall be saved during profile sequence acquisition (see also "Profile sequence acquisition" on page 136).

Displaying Profiles

The **Profile Display** window is used for displaying the extracted profiles.



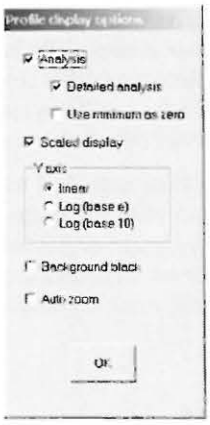
Profile display window

*Note: The system is not able to compare profiles with the same physical dimensions but with different units like **mm** and **cm** or **m**.*

The full area of the **Profile Display** window is used to display the profiles. Several profiles can be displayed at a time, provided that the scaling unit is the same. (The scaling may be different, but the unit must be the same.) Hence it is possible to simultaneously display profiles which were derived from different images, even with different scaling (see also "Scaling Set-up: Using Different Scaling Methods" on page 63).

Above the profile display you will find a task bar with functions to save and load ROI sets, to print profiles and to set some preferences.

	Print Profile	Prints the profile display window on your printer
	Save ROI	Save the actual set of ROIs
	Load ROI	Load a previously saved set of ROIs
	Unzoom	Zooms out completely. (Then the intrinsic limits will determine the zoom ranges).
	Zoom last	Restores the last zoom setting. This is useful is you have zoomed too deeply into a profile and you want to get back one step. Note: By using this command repeatedly you can alternate between two defined zoom settings.
	Zoom all	Optimises the zoom factor to display all actual profiles in a maximum size
	Options	Opens a dialogue box to set profile display options



Profile options

In the profile display options dialogue you can set following parameter:

When **Analysis** is selected, two cursors appear on the **Profile Display** Window and the **Profile Analysis** window appears on the screen.

The option **Detailed Analysis** and **Use Minimum as zero** are explained in the chapter "Profile Analysis".

When **Scaled Display** is active, the scaling data attached to the profile is used to get the correct physical value for every data point. If **Scaled display** is inactive corresponding pixel values are displayed. With this option you can even display profiles with different units. All analysis values are displayed in scaled values or in pixels according to this option.

There are three different possibilities for display of the intensity axis. It can be either displayed linear or logarithmic with the base 10 or with the base e. This can be selected by choosing one of the options **Linear, Log(base e)** or **Log(base 10).**

Background black determines whether the profile background will be displayed black or white.

If **Auto zoom** is selected, the system performs a zoom operation whenever a profile has been changed. This ensures that always the best display mode is selected to show all actual profiles within the display window with maximum size (like the Zoom all button).

By using the mouse you can interactively **zoom** into a portion of the profile as follows:

- Move the mouse cursor to one of the corners which defines the area you want to zoom in.
- Press the **right** mouse down.
- Move the mouse to the opposite corner of the area you want to zoom in.
- Release the mouse button.

You can repeat this process as often as you like.

Every profile has its intrinsic **data limits**. These are defined by the first and last data point in the X direction and by the data type and the detailed circumstances of the exposure in the intensity direction. When the **Unzoom** function is executed these intrinsic limits are used to define the zoom ranges. If more than one profile is displayed the absolute maximum and minimum values of the intrinsic

limits of all these profiles are determined. The intrinsic limits for different type of data are as follows:

If a memory contains a profile the "Mn" text on the push-button is underlined. In addition, the type of profile can be determined by the small symbol below the button.

\ is displayed for line profiles,

— for integrated horizontal profiles and

| for integrated vertical profiles.

s profile sequence

f profile file

j result of jitter correction

a averaged profile

If a memory contains a profile which is not hidden than the background colour under the symbol is the same as the profile's colour. If it is hidden, that colour is white.

You can temporarily hide a profile by clicking the **Hide** button in the Profile control dialogue box. But the system may also hide a profile automatically. This happens if you display a scaled profile with a unit different to that of other profiles in the display. In this case, the other profiles will be hidden (until you **show** them again).

When selecting **Print Profile** from the **Profile Display** window the systems sends a hard-copy of the current **Profile Display** window to the Windows printer currently installed.

Profile Scaling

In the moment a profile is generated the scaling information is transferred from the image to the profile (see also "Scaling Set-up" on page 63). When an integrated horizontal or vertical profile is generated the scaling for the corresponding axis is transferred from the image to the profile. If a line profile (arbitrary direction) is generated scaling information is only transferred when the scaling for both axes are linear and have the same unit. If the scaling factor is not the same for both directions, the angle of the profile sampling line is taken into account and a new scaling factor which is corrected for the profile direction is calculated. If the starting point of the line is Sx,y, the ending point of the line is Ex,y and the scaling factors are SCx and SCy, then the new scaling factor SCn is:

$$SC_n = \sqrt{\frac{((S_x - E_x)*SC_x)^2 + ((S_y - E_y)*SC_y)^2}{(S_x - E_x)^2 + (S_y - E_y)^2}}$$

The numerator is an expression for the scaled length of the line, while the denominator is an expression for its pixel length.

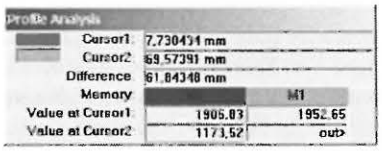
Scaling information cannot be attached to the profile when the profile sampling window is extended beyond the valid image area (because the image scaling is defined only inside the valid image area) and a warning message will appear.

The user can select among following possibilities:

- If the user selects **Clip profile to image area** the overlapping area between the valid image and the previously selected profile sampling window is used for the profile generation.
- If the user selects **Get new profile** he can define the profile sampling window again. The previously selected area will serve as the default.
- If he selects **Extend scaling data linearly** the scaling factor is calculated as if the profile sampling window had been within the valid image. This works only for linear scaling.
  The user can select whether he wants to clip the profile sampling window to the valid image.
- If the user selects **Do not assign scaling data** the profile will obtain no scaling at all (will remain non-scaled, and its values will be pixels).

Profile Analysis

When **Analysis** from the **Option** menu of the Profile Display window is selected, the **Profile Analysis** window will appear on the screen in its standard size and two cursor will appear within the **Profile Display** window.



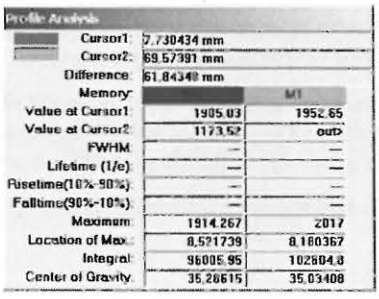
Profile analysis window

You can move the cursors by clicking and dragging them with the left mouse button (like the cursors on the LUT tool). The profile analysis display shows the X-values (pixel numbers or scaled values) and the difference between the two cursors. This is useful for measuring distances. It also shows the intensity values of all profiles at the cursors locations. If the cursor is out of the range of a profile the strings "out>" or "<out" will appear instead of a number.

Note that the movement of the cursors is not bound to the profile channels. If you move them between two channels an interpolated value between the two neighbour channels will be used. The colours of the profiles are displayed in the text box showing the memory numbers. This Profile Analysis window can show the intensity values of all memories at one time (up to 10 memory buffers). If more memories are going to obtain profiles the width of the window will increase automatically.

When **Scaled Display** is selected under the **Options** menu all values are scaled values, otherwise all displayed values are pixel values. During movement of the cursors the values **Cursor1, Cursor2, Difference, Value at cursor1** and **Value at cursor2** are updated continuously.

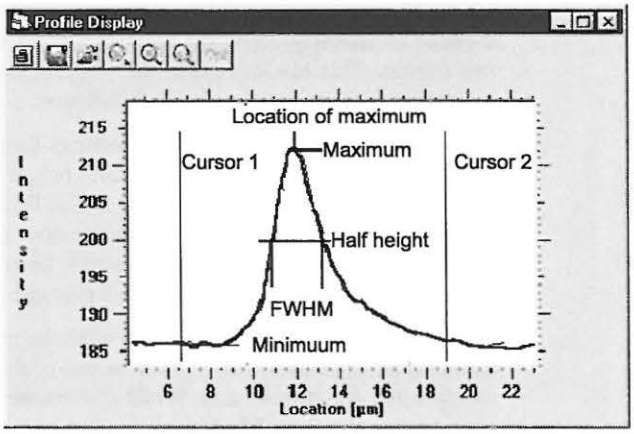
If the **Detailed analysis** is selected under the **Options** menu several additional numerical values will be displayed.



Profile analysis window (extended type)

The profiles are analysed in the region between the two cursors and the values for **FWHM** (full width at half maximum), **Lifetime, Risetime, Falltime, Maximum, Location of Max., Integral** and **Center of Gravity**. These values are updated when the cursor is placed at a certain location and the mouse is released. They are not continuously updated during mouse movement.

All these analysis functions first search for the absolute maximum in the interval between the two cursors.



Data which are analysed from an intensity profile

It does not matter whether cursor 1 is at the right side of cursor 2 or vice versa. The region for the analysis is always extended to the next measuring point. (This may be important to know when the selected area is very small.) After the absolute maximum has been found, the profile is scanned until its value becomes smaller or equal to a certain value. (For example, for the FWHM this value is just half the value of the maximum.) When the value lies between two data values a linear interpolation is made to find an estimation for the correct value.

For some functions the "zero point" has to be determined. By default this point is exactly at intensity =0. However, if the option **Use Minimum as zero** under the **Options** menu is selected the minimum found in the region between the two cursors is regarded as the zero point. This is very useful if the profile contains an undesired offset.

The values are calculated as follows:

Value	Search starts at	Direction	Search value	Search value if "Use Minimum as zero"
FWHM right	Maximum	to right	(Max)/2	(Max+Min)/2
FWHM left	Maximum	to left	(Max)/2	(Max+Min)/2
Lifetime top	=Maximum			
Lifetime right	Maximum	to right	Max/exp(1)	(Max-Min)/exp(1)+Min
Risetime 10%	Maximum	to left	Max*0.1	(Max-Min)*0.1+Min
Risetime 90%	Maximum	to left	Max*0.9	(Max-Min)*0.9+Min
Falltime 90%	Maximum	to right	Max*0.9	(Max-Min)*0.9+Min
Falltime 10%	Maximum	to right	Max*0.1	(Max-Min)*0.1+Min

FWHM=FWHM right-FWHM left

Lifetime=Lifetime right-Lifetime top

Risetime=Risetime 90%-Risetime 10%

Falltime=Falltime 10%-Falltime 90%

Note: The purpose of these simple analysis functions is to get fast information about the profile characteristics. The usefulness for precise analysis, however, is limited.

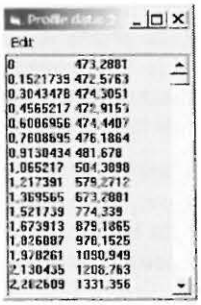
Integral calculates the integral (area under the profile) between the two cursors. (This can e.g. be used to calculate pulse energies).

Center of Gravity calculates the center of gravity of the profile between the two cursors. This can be used to calculate the position of a relatively broad pulse with greater precision than the Peak function.

This fast analysis cannot replace a thorough data analysis which is often necessary. Especially the fast analysis tends to be quite sensitive to noise. A thorough analysis would often require treatments like Fourier analysis, filtering, curve fitting, etc. which are out of scope of the functions built into the **HPD-TA** .We recommend to use specialised software for those higher requirements. See also "Using the Clipboard and DDE Links" on page 168.

To visually check the search values which the profile analysis routines used to calculate analysis data simply click on one of the values in the Profile Analysis window you are interested in. While any mouse button is held down small red ticks appear on the profile display window showing the location of the search values.

Displaying Profile Data



Profile display text box

When the **Data** command is selected on the **Profile Control** dialogue box the content of the profile data is displayed in a text box **Profile X Data** where X stands for the number of the profile (e.g. Profile 0 Data).

The data contains two entries for each data point (X and Y) separated by a TAB character. The data points are separated by CR+LF characters. X is the assigned scaling value and Y the intensity value.

Using the Clipboard and DDE Links

When the profile data is displayed in a text (see "Displaying Profile Data" on page 168) you can easily fill the clipboard or establish a DDE link to another application. To do so proceed as follows:

- Copy the content of the text box to the clipboard by selecting the **Edit Copy** (Ctrl C) command of the text box.

- Select the other application (like Microsoft Word for Windows, Microsoft Excel) and select either **Paste** (for pasting the clipboard contents) or the **Paste Link** function (some applications may use a different command name).
- Data are now transferred. In case od DDE, the link is now established. Whenever the data is changing, the other application gets the new data via DDE link.

This function can be used to make profile display or analysis within a separate program. Remember that the profile data are updated automatically after image acquisition if the auto update checkbox is checked within the profile control dialogue box.

Histogram Analysis

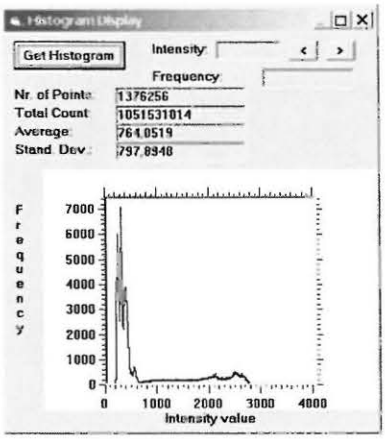
Histogram analysis is a statistical analysis of intensity data within an user-defined area of interest

Choose **Histogram** from the **Analysis** menu to display the Histogram window.

Select an rectangular Area of Interest ("Selecting Regions of Interest (ROIs)" on page 41) If no area is defined, the histogram will be calculated from the whole image area.

Click **Get Histogram** to get the intensity histogram.

The histogram window displays the calculated histogram. By clicking the right mouse button and moving the mouse into the histogram display a cursor will appear. You can see some statistical data for the selected intensity like how often this intensity value appears in the specified region (**Total Count**), average intensity value (**Average**)or standard deviation (**Stand. Dev.**). These data may sometimes be useful for signal characterisation (e.g. noise characterisation). Move the cursor to inspect the data of other intensity values. By using the **<** and **>** arrow buttons you can move the cursor position in single steps.



Histogram window

Note: Due to technical reasons 14 and 16 bit image data can be analysed by the Histogram function only with reduced accuracy.

3D Data

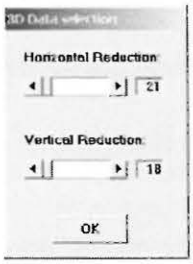
This function allows to display numerical intensity data from within an user-defined area of interest.

Extract 3D Data from an Image

Image data can be displayed in a text box. As the maximum number of characters in a text box is 32000 not all pixels values can be displayed. Therefore only every n^{th} Pixel value is displayed. n is determined by the size of the area to display.

Tool to define an area ROI

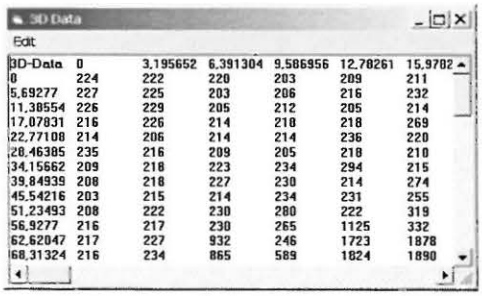
Choose **3D Data** from the **Analysis** menu. Than the user is prompted to select the area from where to extract the 3D data (see "Selecting Regions of Interest (ROIs)" on page 41). According to the size of the area one has to select the factor n for every direction from the 3D data selection dialogue box.



3D data selection dialogue box

The minimum values for the horizontal and vertical reduction (means maximum amount of data) are predefined. If one wants to select less data points one has to increase the values for horizontal and vertical reduction. After you click OK the 3D Data will be extracted from the current image and its numerical values will be displayed in the 3D Data dialogue box.

The pixels values of one line are separated by TAB characters. Different lines are separated by CR+LF characters. The first line contains scaling information in the X direction, The first column contains scaling information in the Y direction.


3D Data

Edit

3D-Data	0	3,195652	6,391304	9,586956	12,78261	15,9782
0	224	222	220	203	209	211
5,69277	227	225	203	206	216	232
11,38554	226	229	205	212	205	214
17,07831	216	226	214	210	218	269
22,77108	214	206	214	214	236	220
28,46385	235	216	209	205	218	210
34,15662	209	218	223	234	294	215
39,84939	208	218	227	230	214	274
45,54216	203	215	214	234	231	255
51,23493	208	222	230	280	222	319
56,9277	216	217	230	265	1125	332
62,62047	217	227	932	246	1723	1878
68,31324	216	234	865	589	1824	1890

3D Data dialogue box

Using the Clipboard or a 3D Data DDE Link

A DDE link can be established similar to the links which can be established with profile data. To do so please perform the following:

- Copy the content of the text box to the clipboard by selecting the **Edit Copy** (Ctrl C) command of the text box.

- Select the other application (like Microsoft Word for Windows, Microsoft Excel) and select either **Paste** (for pasting the clipboard contents) or the **Paste Link** function (some applications may use a different command name).
- Data are now transferred. In case od DDE, the link is now established. Whenever the data is changing, the other application gets the new data via DDE link.

This feature can be used to display and analyse 3D Data.

Fitting

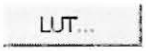
The Fitting module is available if the TA-Fit is enabled (If you purchase the TA-Fit your hardware lock will contain a key for this option, thus enabling the Fitting function). An item **Fitting** will appear in the **Analysis** menu. Click **Fitting** to open the main Fitting window. Please refer to the manual "TA-Fit User Manual" about how to operate the fitting module.

Display Menu

Overview

Under the Display menu several functions related to image display can be accessed.

The **Display** menu contains the command **LUT**.

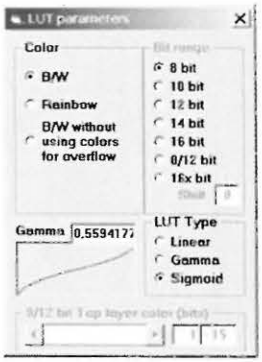


Display menu

LUT (Look up Table)

With this function you can select if images shall be displayed in black and white or pseudocolour.

Choose **LUT** from the **Display** menu to display the LUT parameters dialogue box.



LUT parameter dialogue box

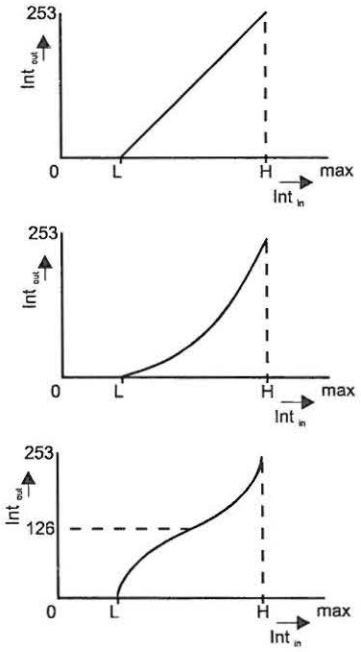
Within the dialogue box you can select the LUT type (either black-and-white or rainbow) by clicking to the **B/W** or **Rainbow** radio button in the **Color** frame.

B/W will produce a grey scale display where data overflow is marked by yellow and red colour, while **Rainbow** will produce a pseudo-colour display where different intensities are coded as different colours. **B/W without using colors for overflow** will produce a grey scale display where data overflow is not marked by yellow and red colour. (see also "LUT Tool" on page 36)

Warning: When using the program with a streak camera or a camera with image intensifier, you should **not use** the setting **B/W without using colors for overflow,** since it is difficult to recognise over exposure of the tube, which may damage your detector system!

LUT type

There are three types of LUT (see also „Non-linear contrast enhancement" on page 38):



- Linear LUT (default), which makes a linear grayscale transformation between the input image data and the displayed data.

$$Int_{out} = \frac{Int_{in} - L}{H - L} * 253$$

- Gamma, which makes a nonlinear grayscale transformation according to following algorithm:

$$Int_{out} = \left[\frac{Int_{in} - L}{H - L} \right]^{k} * 253$$

- Sigmoid, which makes a nonlinear grayscale transformation according to following algorithm:

$$\text{where } Int_{in} < \frac{H - L}{2} + L: \quad Int_{out} = \left[\frac{Int_{in} - L}{\frac{H - L}{2}} \right]^{k} * 126$$

$$\text{where } Int_{in} \geq \frac{H - L}{2} + L: \quad Int_{out} = 253 - \left[\frac{H - Int_{in}}{\frac{H - L}{2}} \right]^{k} * 126$$

Choose LUT type according to your desire by selecting the related radio button in the LUT type section.

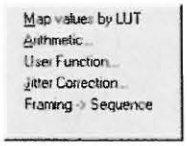
Set the Gamma or Sigmoid parameters either by clicking in the box where the transfer curve is drawn and dragging the curve (current image will be updated immediately) or by inserting the desired factor in the textbox Gamma followed by pressing the enter key to activate the new factor.

Processing menu

Overview

Under the Processing menu several functions for image processing are listed.

The **Processing** menu contains the functions **Map values by LUT**, **Arithmetic...**, **User Function...**, **Jitter correction** and **Framing > Sequence**.



Processing menu

Map Values by LUT

This command reduces image bit depth to 8 bit intensity range.

Choose **Map values by LUT** from the **Processing** menu to change the bit depth of the current image to 8 bit.

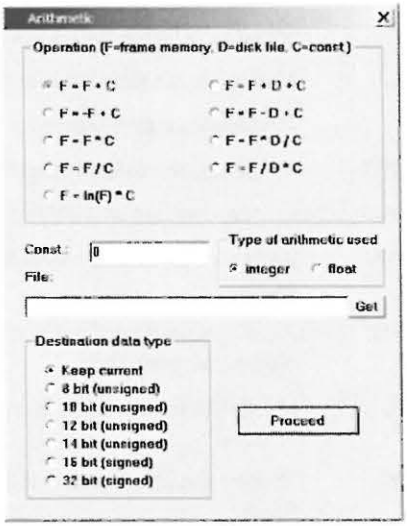
This command irreversibly destroys a part of the information in the original image. Use it with care.

If you issue this command the data of the specified area of interest from the current image are rewritten to it in such a way that they will contain the values which are currently output by the LUT. The LUT size is then changed to 8 bit and the LUT cursors are set to 0 and 256. After completion of this command the image looks exactly like it has been before, the data, however, are reduced to 8 bit range. This may be useful when working with other image analysis software which does not support images with more than 8 bits. (see also "Save As .." on page 50).

Arithmetic

Arithmetic operations on an image or among two images can be made by using the Arithmetic commands.

Choose **Arithmetic** from the **Processing** menu to display the Arithmetic dialogue box.



Arithmetic dialogue box

Caution: *Save your original image first if you need to keep it.*

The arithmetic functions can be used for tasks like subtracting or multiplying two images. These functions will always work on the current image and will change that image.

Both, unary and binary operations are possible. In case of binary operations the first operand is always the current image and the second operand is always an image in a file on a disk.

The Area ROI tool

You can select a partial area of the image and the function will be performed only inside that area (see "Selecting Regions of Interest (ROIs)" on page 41).

In case of binary operations the system always automatically calculates the overlapping area between the two images and will perform the function only on that area. After the operation is finished the systems valid image area will be set to that area.

In addition, for all functions (also the unary ones) a constant may be defined as a calculation parameter. This constant has to be input into the edit box named **Const.**

For the binary operations the name of the file which contains the second operand image must be defined. Press the **Get** button to open a dialogue and select a image file.

You may also specify which type of arithmetic is used for the calculations, (long) integer or floating-point arithmetic. If the given constant is an integer value by default the arithmetic type is integer but you can force the program to use floating-point arithmetic, if you like. Choose the desired radio button in the frame **Type of arithmetic used.**

Note : The data type (bit range) of the resulting image may be different from the operand images. You can influence the type of the result by using the radio buttons in the frame **Destination data type**.

Note: This function can also be used to convert the bit range of an image without altering it otherwise. Just select the function F=F+C with C=O, for example.

After you pushed the **Proceed** button the program calculation will start.

Note: The time required for an calculation will depend on the speed of your computer.

The following unary operations are available:

F=F+C Adds a constant (integer only)

F=-F+C	Inverts the frame-buffer contents (integer only)
F=F*C	Multiplies the frame-buffer by a constant (integer or float)
F=F/C	Divides the frame-buffer by a constant (integer or float)
F=ln(F)*C	Calculates the natural logarithm (float only)

The following binary operations are available:

F=F+D+C	Adds a constant and a disk file to the frame-buffer (integer only)
F=F-D+C	Adds a constant and subtracts a disk file from the frame-buffer (integer only)
F=F*D/C	Multiplies the image in frame-buffer with a disk file (integer or float)
F=F/D*C	Divides the image in frame-buffer by a disk file (integer or float)

All integer operations are performed with long integers (4 byte) and are done in a way to minimise rounding errors (e.g. multiplication is done before division etc.). After the calculation clipping is performed to keep the values within the range of the destination data type. The lower and upper clipping values for the different data types are as follows:

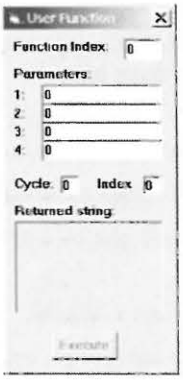
Data type	Lower	Upper
8 bit	0	255
10 bit	0	1023
12 bit	0	4095
14	0	16383
16 bit	-32768	+32767

User Function

*User function is a feature that allows the user to implement any own functionality at specific locations within **HPD-TA** E.g. control of other devices or online analysis of data.*

Choose **User Function** from the **Processing** menu to display the User function dialogue box.

This function is kept for compatibility reasons with elder versions. To perform similar tasks and even more complex tasks the powerful **Remote Control** SDK is now available. Please contact your supplier for more detailed information.



User function dialogue box

User function is a feature of **HPD-TA** which allows the user to implement his own routines into the system. When the option **User Functions** from the **Options** menu is selected, the system calls the function `UserFunction` within a DLL with the name CUSTOMER.DLL from various locations. The definitions of the Function `UserFunction` is given below:

```
int FAR PASCAL UserFunction(int iIndex, char far *
sStatusString, int iStringLen, char far * sBackString,
int nBackStringMaxLen, int far * nBackStringLen, float
ftPar1, float ftPar2, float ftPar3, float ftPar4, int
iCycleIndex);
```

A dummy DLL is already delivered with the distribution disk and can be used as a prototype to built user-specific functions. The function **`UserFunction`** is called from various locations from within **HPD-TA** e.g. before and after an acquisition. The dummy DLL contains a list of all locations from where the Function is called. The parameter `iIndex` indicates from which location within **HPD-TA** the call came (e.g. Start of Acquire, Live etc.)

The meaning of the parameters are as follows:

Parameter	Meaning
`iIndex`	Location from where the call came
`sStatusString`	Status string indication information about the image
`iStringLen`	Length of the status string in bytes
`sBackString`	String which can be handled back to **HPD-TA** Under certain circumstances this string is appended to the comment area of the status string (see below).
`nBackStringMaxLen`	Maximum number of bytes for the string of `sBackString`
`nBackStringLen`	Length of the string handled back (must not be bigger than `nBackStringMaxLen`)
`ftPar1`	Parameter which can be handled to the Function*
`ftPar2`	Parameter which can be handled to the Function*
`ftPar3`	Parameter which can be handled to the Function*
`ftPar4`	Parameter which can be handled to the Function*
`iCycleIndex`	Cycle number (when the Function called from within the cycle, Index numbers 25, 26, 27 only)

*: The user has to input these parameters in the user function dialogue box

Memory and Display parameters
- handled to the UserFunction with the sBackString parameter -

2,-1,0,0,1000,1018,0,0,1000,1018,0.25,3288,1688,
0 1 2 3 4 5 6 7 8 9 10 11 12

4,140,297,485,309,148176908,2097152,150274064,1048576,
13 14 15 16 17 18 19 20 21

123896328,1318,96622516,10340,LIVE (0),0,3
22 23 24 25 26 27 28

0: iBytesPerPixel
1: fDisplayOnVGA
2: areSource.iX
3: areSource.iY
4: areSource.iDX
5: areSource.iDY
6: areImgToDisplay.iX
7: areImgToDisplay.iY
8: areImgToDisplay.iDX
9: areImgToDisplay.iDY
10: ftZoom
11: FormImageDisplay.hwnd
12: FormImageDisplay.PicImage.hwnd
13: iROIType
14: areROI.iX
15: areROI.iY
16: areROI.iDX
17: areROI.iDY
18: lDataHandle
19: lDataBytes
20: lDisplayHandle
21: lDisplayBytes
22: lStatusHandle
23: lStatusBytes
24: lScalingHandle
25: lScalingBytes
26: sFileName
27: fDataSaved
28: iPRFDirection

Notes:

areSource:	Coordinates of the stored image.
fDisplayOnVGA:	0=Image is not displayed, -1 is displayed on the VGA screen
areImgToDisplay:	Coordinates of the image which is display within the window FormImageDisplay.PicImage
ftZoom:	Zooming factor range: 0.25, 0.5, 1, 2, 4
FormImageDisplay.hwnd:	Handle of the Window containing the displayed image including caption, white areas and scroll bar.
FormImageDisplay.PicImage.hwnd:	Handle of the Window containing the image area (areImgToDisplay) only.
iROIType:	NONE =0, ZOOM = 1, ROIPOINT = 2, ROILINE = 3, ROIRECTANGLE = 4, ROIMODIFY = 5
areROI:	Area of the user specified ROI.
lDataHandle:	Memory is allocated with the GlobalAlloc function. To use the memory call lpvData=GlobalLock(lDataHandle) to unlock it call lpvData=GlobalUnlock(lDataHandle).
lDataBytes:	Number of Bytes allocated for the data.
LDisplayHandle, lDisplayBytes:	Same for Display data (8 bit per pixel)
LStatusHandle, lStatusBytes:	Memory area used to store the status string in the case another image is activated.
lScalingHandle, lScalingBytes:	1280 single (=float, 4 byte) values containing the scaling table, in the case table scaling is used

sFileName:	Name which appears in the image caption. In the case the image is saved it contains the full path of the file name.
fDataSaved:	0 if the image data is created or modified, -1 if the image is saved.
iPRFDirection:	Direction of the quick profile (HORINTEGRPROFILE = 2, VERINTEGRPROFILE = 3)

If the image does not exist (e.g. if the UserFunction is called prior to the acquisition) the sBackString is empty and iLenBackString=0.

If the string exceeds 255 characters it will be truncated to 255 characters.

The **User function** dialogue box can be used to check the DLL function. It allows to enter the function index and the 4 parameters and returns the Cycle number, the index number and the returned string. The 4 free parameters which are entered at the corresponding locations are always passed to the function independent whether the function is called from the User function dialogue box or from within **HPD-TA** . These parameters can be used to rule specific behaviour or the user function. See "Appendix I: UserFunction" on page 202 for a printout of the prototype UserFunction.

Framing > Sequence

This command allows to convert a single image acquired with a framing camera into a sequence of images.

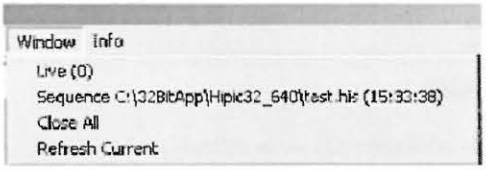
After you selected the command Framing > Sequence, one framing image will be split up into several images and they will be treated like a sequence of images. The dialogue box for sequence display will be opened (see "Sequence" on page 129).

Before you can use this function, you have to make a framing camera image setup (see "Framing Camera" on page 85).

Window Menu

Overview

The Window menu includes commands to show all open windows and select an new active window. You can close windows and refresh a window in this menu



In the upper part of the menu dialog you find the list of open image windows.

The active window is indicated with an...

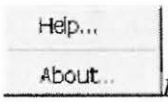
The command Close All closes all open image windows. If unsafed windows are present a dialogue will pop up where yu are asked if you want to to save the image.

The command Refresh Current refreshes the display of the currenmt image window.

Info Menu

Overview

The **Info** menu includes the **Help**, **RS232** and the **About** command.



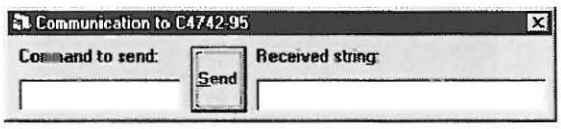
Info menu

RS232

This command is not available it the DCam driver configuartion is used. The RS232 command can be used to watch or send control commands to the C4880 or C4742 camera. It is mainly intended for diagnostics purposes and should not be used under normal circumstances.

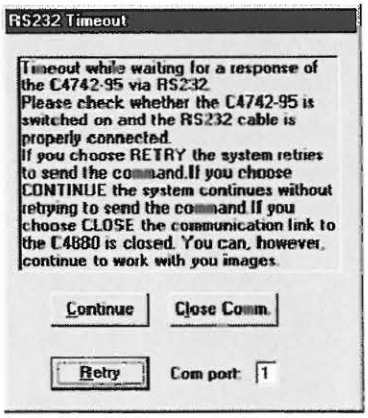
If you choose **RS232** from the **Info** menu the Communication dialogue box appears. It shows the commands sent to the camera by the program and the response strings received from the camera. Also, the user can send commands to the camera manually (see the camera manual for details on the commands and their syntax). To send a command, write your command into the text box **Command to send** and push the **Send** button. The received response string is displayed in the display box **Received string**.

As long as the input focus is at the RS232 dialogue box the user no longer can see commands sent and strings received in the meantime (Otherwise the user's commands would be permanently overwritten by the system's commands and could not be entered correctly). Once the user sets the focus to another window the RS232 dialogue box continues to display all system messages.



RS232 communication dialogue box

If, at any time during program operation, there should be a time-out problem with the serial communication to the camera, the program will display the following **RS232 Timeout** dialogue box.



RS232 Timeout dialogue box

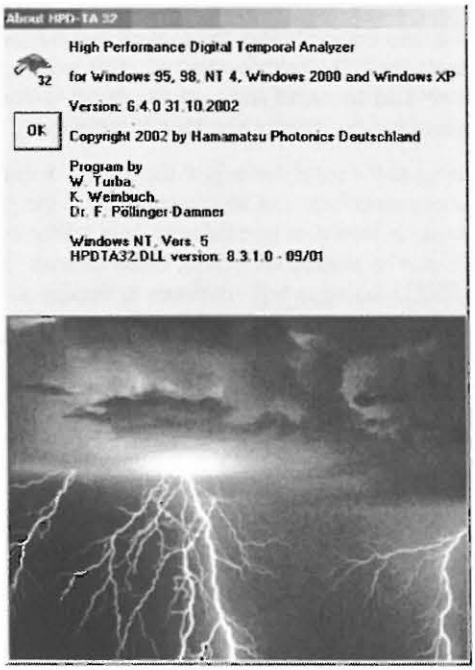
You can either select **Retry** to retry to communicate via RS232, **Continue** to continue the program without sending the command, or **Close** to close the communication link. When selecting **Retry** you can change to another COM port.

Help

If you select the Help menu, the help file will be opened. This is a Adobe Acrobat file in PDF format. You need to have Acrobat Reader installed to read the file. You can find a copy of the Acrobat Reader on the installation disk.

About

The About dialogue box informs the user about the current version of the program.



About dialogue box

Appendix

Appendix A: Files Used in HPD-TA

The program uses several kinds of files for data storage, export and parameter storage. There are several different programs (such as "HiPic", "HiPic/EM", "HIPIC", "HPD-TA") offered by Hamamatsu which share the same file formats. These programs can easily exchange data. Sometimes the identification keyword "HiPic" is used to identify these common file formats independent of the program which created the file. The file format is also defined by a version identifier because the format may change to support new features of new program versions. The current file format identifier is 5.0.

Following files are used:

- Configuration files like: DIGITAL.CNF, CCIR.CNF and EIA.CNF. These files are used to correctly initialise the frame grabber board for certain operation modes, cameras and monitors. Refer to your frame grabber hardware reference manual and your ITEX programmers manual for details (if you have purchased the ITEX library).
- Image files: *.IMG. The ITEX file format is used. The image status is stored in the comment string of an ITEX file (see Appendix E for details). Either 8, 16 or 32 bit files are generated in non compressed form.
- HIS sequence (Hamamatsu Image Sequence). This format is similar to the *.IMG format but can contain a sequence of images.
- TIFF image files. 8 and 16 bit grey-scale TIFF images are used to save the data. 8 bit TIFF images are used to save the display.
- Profile files: Profiles are stored in ASCII format. See Appendix C for details.
- Dynamic photon counting image filed *.dpc: This is a special file format used for recording dynamic photon counting images. See Appendix G for details.
- The WINDOWS initialisation file: HPDTA32r.INI . It automatically stores parameter settings which are re-used the next time the program is started.

Appendix B: Image File Format

The .IMG file format used in **HPD-TA** is compatible to the ITEX format. It is described in the Appendix A of the ITEX documentation. We reproduce it here:

Bytes	Content

0-1	Characters IM
2-3	Comment length (byte)
4-5	Width of the image in pixels
6-7	Height of the image in lines
8-9	X-Offset
10-11	Y-Offset
12-13	File type:
	0=8 Bit, 1=Compressed (Not used by **HPD-TA**), 2=16 Bit, 3=32 Bit
14-64	Reserved
64-nnn	Comment area containing the status string (see Appendix E)
nnn+1-End	Data Area (one or two bytes per pixel stored in row order from the top to the bottom of the image)

TIFF images are stored using TIFF format version 6.0. When scaling tables are used, these are appended to the normal data according to the status string which is saved in the comment tag (see Appendix D).

Note: If Table scaling is used, the scaling tables are stored after the end of this section (see Status string entries for details).

HIS (Hamamatsu Image Sequence) File format:

Following is a detailed description of the HIS file format:

A) General

There are two types of headers (wirt almost identical format)

1.) First header of every channel
2.) Header describing all following images within a sequence

The content is:

1. First header of every channel
- Image format (width etc.)
- Channel number
- Number of images in the file
- Number of additional cannels
- Time stamp
- Marker
- Info about channel x (Comment string, variable length)

This header has variable length size (Length is determined by)

2. Header describing all following images within a sequence
- Image format (width etc.)
- Channel number
- Time stamp
- Marker

This header is fixed size (64 bytes)

The header is always immediately followed by the data of one image.

B) Universal case

1. First header of every channel

Bytes	Content
0-1	Character IM
2-3	Comment length in Bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit (not used now), 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now)
14-17	Number of images in this file for this channel (-1=unknown)
18-19	Number of additional channels in the file
20-21	Channel number
22-29	Time stamp of image 0 (double)
30-33	Marker
35-64	Additional information (can be used freely by the application)
64 to 64+ComLen-1	Comment area can contain any information. There is no restriction in lenght (except that a two byte variable is used for specifying the length). The HiPic/HPDTA stores a string in the format of an INI file and scaling tables here (if scaling is table type).

64+ComLen to 64+ComLen+DatLen-1	Data of image

2. Header describing all following images within a sequence

Bytes	Content
0-1	Character IM
2-3	=0
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit (not used now), 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now)
14-17	=0
18-19	=0
20-21	Channel number
22-29	Time stamp of image 0 (double)
30-33	Marker
34-64	Additional information (can be used freely by the application)

DatLen Bytes	Data of image

C) Standard case (one channel)

1. First header of every channel

Bytes	Content
0-1	Character IM
2-3	Comment length in Bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit (not used now), 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now)
14-17	Number of images in this file (-1=unknown)
18-19	=0
20-21	=0
22-29	Time stamp of image 0 (double)
30-33	Marker
34-64	Additional information (can be used freely by the application)
64 to 64+ComLen-1	Comment area can contain any information. There is no restriction in lenght (except that a two byte variable is used for specifying the length). The HiPic/HPDTA stores a string in the format of an INI file and scaling tables here (if scaling is table type).

64+ComLen to 64+ComLen+DatLen-1	Data of image

2. Header describing all following images within a sequence

Bytes	Content
0-1	Character IM
2-3	=0
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit (not used now), 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now)
14-17	=0
18-19	=0
20-21	=0
22-29	Time stamp of image 0 (double)
30-33	Marker
34-64	Additional information (can be used freely by the application)

DatLen Bytes	Data of image

Appendix C: Profile File Format

The format of the profiles files written by **HPD-TA** is as follows:

;"HiPic 6.2 Profile" 1.)

;"HiPic,5.0,1,4.0,3,6,3,3,373,3868,1,01-28-1994..." 2.)

;585,70,799,411 3.)

;342,0,3 4.)

;1,1.515152,"ps ","scal1 " 5.)

0,357.4605

1.515152,360.8232

3.030303,354.1535

4.545455,352.8047

1) Identification line (contains ;"HiPic 6.2 Profile").
2) Status string in "" (see Appendix D), preceded by semicolon.
3) Start and end position of the profiles in the form:
   StartX, StartY, EndX, EndY. For Integrated profiles it indicates the position of two opposite corners of the rectangle used for integration, preceded by semicolon.
4) Number of data points, X-Offset (always 0) and Profile Type:
   1=line, 2=Integrated horizontal, 3=Integrated vertical, preceded by semicolon.
5) Scaling Type (1=Linear, 2=Table), Scaling Factor (linear scaling only), Unit in "", Scaling file without extension (table scaling only), preceded by semicolon.
6) Data in subsequent lines, as many lines as number of data points. Format: X, Y value

Appendix D: Status String Format

The status string is a string which is attached to an image and to profiles derived from an image. It contains all information about the image. The following is a sample string and the description of the different information. The status string contains only ASCII strings separated by comma.

The image status in this version is formatted differently from former versions.

The image status is saved as one string and it is organized like a *.INI file. It contains different sections where every section can contain tokens with assigned values. Other programs like remote control client programs or just any different image processing programs can add their own sections to save special data without disturbing the HiPic or HPD-TA. It is, however, important to know that several of the entries in the status string are mandatory. Otherwise the file cannot read by the programs correctly. So be careful if modifying any of the tokens mentioned here. This is especially important for the Sections [Acquisition] and [DisplayLUT].

As an example we take the following status string (It was created when acquiring an image from the C7342-95 camera):

```
[Application],Date="06-03-
2004",Time="16:03:46",Software="HiPic",Application=1,ApplicationTitle="High
Performance Image Control Sys-
tem",SoftwareVersion="7.0.0",SoftwareDate="19.05.2004"
[Cam-
era],AMD=N,NMD=S,EMD=E,SMD=N,ADS=12,SHT=150,FBL=1,EST=1,SHA=F,SFD=F,SPX=2,ATP=
N,CEG=0,CEO=0,ESC=B,TimingMode="Internal timing",TriggerMode="Edge trig-
ger",TriggerSource="BNC",TriggerPolarity="neg.",CCDArea="1280 x
```

```
1024",Binning="2 x 2",ScanMode="Normal",CameraName="C4742-95-
12NRB",Type=7,SubType=7
[Acquisition],NrExposure=1,NrTrigger=0,ExposureTime=16
ms,AcqMode=1,DataType=3,DataTypeOfSingleImage=3,ShadingCorr=0,CurveCorr=0,areS
ource="0,0,1280,1024",areGRBScan="0,0,1280,1024",pntOrigCh="0,0",pntOrigFB="0,
0",pntBinning="1,1",BytesPerPixel=2,BacksubCorr=0
[Grabber],ConfigFile="C:\32BitApp\HiPic32_700\PCDig.txt",Type=3,SubType=1
[DisplayLUT],EntrySize=3,LowerValue=0,UpperValue=4096,BitRange="12
bit",Color=3,LUTType=0,Gamma=1,First812OvlCol=1,Lut16xShift=0,Lut16xOvlVal=327
67
[Scaling],ScalingXType=1,ScalingXScale=1,ScalingXUnit="No
unit",ScalingXScalingFile="No scal-
ing",ScalingYType=1,ScalingYScale=1,ScalingYUnit="No
unit",ScalingYScalingFile="No scaling"
```

The name of every section is enclosed in brackets []. Every token is separated from it's value with a "=" character. The tokens are separated from each other with comma. After one section there can be a Carriage Return – Line Feed combination, but this is optional.

As an example we take the "SoftwareVersion" token with the "Application" section. It's value is "7.0.0". The value can be enclosed by quotes if necessary, but this is optional. Lets take the "EntrySize" token from the "DisplayLUT" section. It's value is "3" (But no quotes are used). When quotes are used the value can even contain commas like the "pntOrigCh" token within the "Acquisition" section. Section and token names are case sensitive which means "camera" and "Camera" are different.

Images created from the HiPic and the HPD-TA can contain the following sections with the following tokens:

[Application]

Token	Type	Description	Example
Date	String	Image creation date	"06-03-2004"
Time	String	Image creation time	15:41:51
Software	String	Creating software	HiPic
Application	Integer	Creating software (see ApplicationType)	1
ApplicationTitle	String	Title of creating software	"High Performance Image Control System"
SoftwareVersion	String	Version of creating software	"7.0.0"
SoftwareDate	String	Version date of creating software	"19.05.2004"

[Camera]

This section can have different values depending on the camera used for acquisition:

In the case of an Analog Camera it has the following tokens:

Token	Type	Description	Example
CameraName	String	Name of the camera	Analog camera
Type	Integer	Camera type	3
SubType	Integer	Camera subtype	0
VideoInput	Integer	Video input	0

FrameTime	String	Video frame time	40ms
ExternalSync	Integer	External Sync (flag)	0
StartAcquisitionField	Integer	Starting acquisition field in sequence mode	ICP_NEXT

In the case of a C4742-95 it has the following tokens:

Token	Type	Description	Example
AMD	String	Acquire mode (N=Normal, E=External)	N
NMD	String	Normal mode (N=Normal, S=Electrical Shutter, F=Frame Blanking)	F
EMD	String	External mode (E=Edge Trigger, L=Level Trigger)	L
SMD	String	Scan mode	S
ADS	String	AD select (possible values are 8 10 or 12)	12
SHT	String	Shutter (number of lines, possible values are de-pening on superpixel set-tings)	1
FBL	String	Frame blanking number (number of frames, possi-ble values are depening on superpixel settings)	1
EST	String	External shutter (number of lines, possible values are depening on superpixel settings)	1
SHA	String	Scan horizontal area (F=Full, K=Kilo)	K
SFD	String	Scan front dummy (flag)	F
SPX	String	Superpixel (possile values are depending on camera version)	2
ATP	String	Acquire trigger polarity (P=Positiv, NB=Negativ)	N
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
ESC	String	External source (B=BNC, D=D-Sub, I=Digital I/F)	I
TimingMode	String	Timing mode	Internal timing
TriggerMode	String	Trigger mode	Level trigger
TriggerSource	String	Trigger source	Digital I/F
TriggerPolarity	String	Trigger polarity	neg.
CCDArea	String	CCD area	1024 x 1024
Binning	String	Binning mode	2 x 2

Scanmode	String	Scan Mode (Normal/External)	Normal
CameraName	String	Camera name	C4742-95
Type	integer	Camera type	7
SubType	integer	Camera subtype	7

In the case of a C4880 it has the following tokens:

Token	Type	Description	Example
SSP	String	Scan speed (H=High, S=Slow)	H
SAG	String	Scan amplitude gain (L=Low, H=High, SH=Super High)	H
SMD	String	Scan mode (N=Normal, A=Subarrary, S=Superpixel, B=Binning)	N
SHA	String	Scan horizontal area (F=Full, HC=Half-center, HL=Half-left, HR=Half-right, QC=Quarter-center, QL=Quarter-left, QR=Quarter-Right, EC-Eight-center)	F
SVO	String	Scan vertical offset	0
SVW	String	Scan vertical width	1018
SVB	String	Scan vertical binning	2
SHB	String	Scan horizontal offset	2
SPX	String	Superpixel	2
SOP	String	Scan optical black (flag)	I
AET	String	Acquire exposure time	20ms
ASH	String	Acquire shutter (A=Auto, C=Close, O=Open)	A
AMD	String	Acquire mode (I=Internal, E=External Event, T=External Time, S=External Stop, L=External Level)	I
ATP	String	Acquire trigger polarity (N=Negativ, P=Positiv)	N
ATN	String	Acquire number	1
ACN	String	Acquire cycle number	1
CSW	String	Cooler switch (O=On, F=Off)	F
PSW	String	Panel switch (O=On, F=Off)	O
SHC	String	Shading control (O=On, F=Off)	F
TST	String	Temperature set	-30

CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
CEC	String	Contrast enhancement control (V=Volume, E=through CEG and CEO commands, F=Off)	F
IGC	String	Image intensifier gain control	O
IIG	String	Image intensifier gain	0
TDY	String	Trigger delay	0
AGT	String	Acquire gate time	0
Temperature	String	Temperature	-27.7
CVG	String	Contrast volume gain 0	
CVO	String	Contrast volume offset 31	
CameraName	String	Camera name	C4880
Type	Integer	Camera type	1
SubType	Integer	Camera subtype	1

In the case of a C4880-8X it has the following tokens:

Token	Type	Description	Example
ACN	String	Acquire cycle number	1
AET	String	Acquire exposure time	0
AMD	String	Acquire mode (I=Internal, E=External)	I
ATP	String	Acquire trigger polarity (P=Positiv, N=Negativ)	N
CEC	String	Contrast enhancement control (V=Volume, E=through CEG and CEO commands, F=Off)	V
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
SAG	String	Scan ampitude gain	H
SAR	String	Scan area	0,0,659,493,1
SHT	String	Shutter (number of lines)	500
SMD	String	Scan mode (N=Normal, E=Extended)	N
SSP	String	Scan speed (H=High, S=Slow)	H
Chip	String	Chip	ICX074
VolGain	String	Volume gain	0
VolOffset	String	Volume offset	0
ROM	String	ROM version	2.1D
Version	String	Firmware version	2.5C
Gain	String	Gain 0	
Offset	String	Offset	0

ContrastEnhance-ment	String	Contrast enhancement	Potentiometer
CameraName	String	Camera name	C4880-81
Type	integer	Camera type	8
SubType	integer	Camera subtype	3

In the case of a C4742-98 it has the following tokens:

Token	Type	Description	Example
SSP	String	Scan speed (H=High, S=Slow)	H
AET	String	Acquire exposure time	20ms
AMD	String	Acquire mode (N=Normal, E=External)	N
SMD	String	Scan mode (N=Normal, S=Super-Pixel, A=Subarray)	N
SPX	String	Superpixel (1, 2, 4, 8)	2
SHA	String	Scan horizontal area (F=Full, HC=Half-center, HL=Half-left, HR=Half-right, QC=Quarter-center, QL=Quarter-left, QR=Quarter-Right, EC-Eight-center)	F
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
EMD	String	External mode (E=Edge, L=Level)	L
SFD	String	Scan front dummy (O=On, F=Off)	F
ATP	String	Acquire trigger polarity (P=Positiv, N=Negativ)	N
SVO	String	Scan vertical offset	0
SVW	String	Scan vertical width	1024
SHO	String	Scan horizontal offset	0
SHW	String	Scan horizontal width	1024
Temperature	String	Temperature	50.0
TimingMode	String	Timing mode	Internal timing
TriggerMode	String	Trigger mode	Level trigger
TriggerPolarity	String	Trigger polarity	neg.
CameraName	String	Camera name	C4742-98
Type	integer	Camera type	10
SubType	integer	Camera subtype	11

In the case of a C7300 it has the following tokens:

Token	Type	Description	Example

AMD	String	Acquire mode (N=Normal, E=External)	N
NMD	String	Normal mode (N=Normal, S=Shutter, F=Frame blanking)	F
EMD	String	External mode (E=Edge, L=Level)	L
SMD	String	Scan mode (N=Normal, S=Superpixel, A=Subarray)	N
ADS	String	AD select (8, 10 or 12)	12
SHT	String	Shutter (number of lines)	1
FBL	String	Frame blanking mode (number of frames)	1
EST	String	External shutter (number of lines)	1
SHA	String	Scan horizontal area (F=Full, K=Kilo)	K
SFD	String	Scan front dummy (O=On, F=Off)	F
ATP	String	Acquire trigger polarity (P=Positiv, N=Negativ)	N
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
ESC	String	External source (B=BNC, D=D-Sub, I=Digital I/F)	I
SVW	String	Scan vertical width	1024
SVO	String	Scan vertical offset	0
TimingMode	String	Timing mode	Internal timing
TriggerMode	String	Trigger mode	Level trigger
TriggerSource	String	Trigger source	Digital I/F
TriggerPolarity	String	Trigger polarity	neg.
CameraName	String	Camera name	C7300-10-12NRP
Type	Integer	Camera type	19
SubType	Integer	Camera subtype	12

In the case of a C8000-10 it has the following tokens:

Token	Type	Description	Example
AMD	String	Acquire mode (N=Normal, E=External)	N
EMD	String	External mode (E=Edge Trigger, L=Level Trigger)	E
SMD	String	Scan mode	N
SHA	String	Scan horizontal area (F=Full, K=Kilo)	F
SFD	String	Scan front dummy (flag)	F
SPX	String	Superpixel (1,2 ,4 ,8)	2

ATP	String	Acquire trigger polarity (P=Positiv, N=Negativ)	N
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
SSP	String	Scan speed (H=High, M=Medium, S=Slow)	H
SHO	String	Scan horizontal offset	0
SHW	String	Scan horizontal width	640
SVO	String	Scan vertical offset	0
SVW	String	Scan vertical width	480
TimingMode	String	Timing mode	"Internal timing"
TriggerMode	String	Trigger mode	"Edge trigger"
TriggerPolarity	String	Trigger polarity	"neg."
CCDArea	String	CCD Area	"High"
Binning	String	Binning	"2 x 2"
ScanMode	String	Scan Mode	"Normal"
SubarrayHOffs	Integer	Subarray horizontal offset	0
SubarrayHWidth	Integer	Subarray horizontal width	640
SubarrayVOffs	Integer	Subarray vertical offset	0
SubarrayVWidth	Integer	Subarray horizontal width	480
CameraName	String	Camera name	„C8000-10“
Type	integer	Camera type	21
SubType	integer	Camera subtype	23

In the case of a C8000-20 it has the following tokens:

Token	Type	Description	Example
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
REC	String	Recursive filter	F
RCN	Integer	Recursive filter number	2
BGO	Integer	Background offset	0
HVC	String	High voltage control	F
HVN	Integer	High voltage number	0
CameraName	String	Camera name	„C8000-10“
Type	integer	Camera type	20
SubType	integer	Camera subtype	19

In the case of a Flat panel module it has the following tokens:

Token	Type	Description	Example
AMD	String	Acquire mode (I=Internal, E=External)	I
SPX	String	Superpixel (1, 2, 4)	2
TimingMode	String	Timing mode	"Internal timing"
Binning	String	Binning	"2 x 2"
CameraName	String	Camera name	„Flat panel module“

Type	integer	Camera type	22
SubType	integer	Camera subtype	24

In the case of a C8800 it has the following tokens:

Token	Type	Description	Example
AMD	String	Acquire mode (N=Normal, E=External)	N
EMD	String	External mode (E=Edge Trigger, L=Level Trigger)	L
SMD	String	Scan mode	S
SPX	String	Superpixel (1, 2, 4, 8)	2
ATP	String	Acquire trigger polarity (P=Positiv, N=Negativ)	N
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
ESC	String	External source (M=Multiport, I=Digital I/F)	I
SHO	String	Scan horizontal offset	0
SHW	String	Scan horizontal width	1024
SVO	String	Scan vertical offset	0
SVW	String	Scan vertical width	1024
TimingMode	String	Timing mode	"Internal timing"
TriggerMode	String	Trigger mode	"Edge trigger"
TriggerSource	String	Trigger Source	"Multiport"
TriggerPolarity	String	Trigger polarity	"neg."
Binning	String	Binning	"2 x 2"
ScanMode	String	Scan Mode	"Normal"
SubarrayHOffs	Integer	Subarray horizontal offset	0
SubarrayHWidth	Integer	Subarray horizontal width	640
SubarrayVOffs	Integer	Subarray vertical offset	0
SubarrayVWidth	Integer	Subarray horizontal width	480
CameraName	String	Camera name	„C8800“
Type	integer	Camera type	27
SubType	integer	Camera subtype	38

In the case of a C9100 it has the following tokens:

Token	Type	Description	Example
AMD	String	Acquire mode (N=Normal, E=External)	N
EMD	String	External mode (E=Edge, L=Level)	L
SMD	String	Scan mode (N=Normal, S=Superpixel, A=Subarray)	N

SPX	String	Superpixel	2
ATP	String	Acquire trigger polarity (N=Negativ, P=Positiv)	N
CEG	String	Contrast enhancement gain	0
CEO	String	Contrast enhancement offset	0
EMG	Integer	Electron multiplying gain	20
ESC	String	External source (M-Multiport, I=Digital I/F)	I
SHO	String	Scan horizontal offset	0
SHW	String	Scan horizontal width	1024
SVO	String	Scan vertical offset	0
SVW	String	Scan vertical width	1024
TimingMode	String	Timing mode	"Internal timing"
TriggerMode	String	Trigger mode	"Edge trigger"
TriggerSource	String	Trigger Source	"Multiport"
TriggerPolarity	String	Trigger polarity	"neg."
Binning	String	Binning	"2 x 2"
ScanMode	String	Scan Mode	"Normal"
SubarrayHOffs	Integer	Subarray horizontal offset	0
SubarrayHWidth	Integer	Subarray horizontal width	640
SubarrayVOffs	Integer	Subarray vertical offset	0
SubarrayVWidth	Integer	Subarray horizontal width	480
CameraName	String	Camera name	„C9100-01“
Type	integer	Camera type	26
SubType	integer	Camera subtype	34

In the case of a camera supported by DCam it has the following tokens:

Token	Type	Description	Example
CameraName	String	Camera name	„Hamamatsu 1394 C8484“
Type	integer	Camera type	23
Binning	Integer	Binning	"1“
BinningKeyVal	String	Binning	"2 x 2"
LightMode	Integer	Light mode (0/1)	0
Scan Speed	Integer	Scan Speed	1
Scan Mode	Integer	Scan Mode	2
ScanModeKeyVal	String	Scan Mode	"Subarray"
Hoffs	Integer	Horizontal Offset	0
HWidth	Integer	Horizontal Width	512
VOffs	Integer	Vertical Offset	0
VWidth	Integer	Vertical Width	512
Trigger Mode	Integer	Trigger mode	3
TriggerMode-KeyVal	String	Trigger mode	"Internal"
TriggerPolarity	Integer	Trigger Polarity	"1"
TriggerPolarity-KeyVal	String	Trigger Polarity	"neg."
Gain	Integer	Gain	0

[Acquisition]

Token	Type	Description	Example
NrExposure	Integer	Number of exposures (integrated in memory)	1
NrTrigger	Integer	Number of trigger	1
ExposureTime	String	Exposure time	20ms
AcqMode	Integer	Acquisition mode (see AcqMode)	1
DataType	Integer	Data type (see DataType)	2
DataTypeOfSingleImage	Integer	Data type of a single exposure (see DataType)	2
BacksubCorr	Integer	Background corrected (flag)	0
ShadingCorr	Integer	Shading corrected (flag)	0
CurveCorr	Integer	Curvature corrected (flag)	0
areSource	String	Source area (valid image, X, Y, DX, DY)	0,0,1000,1018
areGRBScan	String	Scan area (for grabber, X, Y, DX, DY)	8,0,1000,1018
pntOrigCh	String	Origin on chip (X, Y)	0,0
pntOrigFB	String	Origin on frame buffer, (X, Y)	0,0
pntBinning	String	Binning (X, Y)	1,1
BytesPerPixel	Integer	Bytes per pixel	1

[Grabber]

Token	Type	Description	Example
ConfigFile	String	Configuration file	D:\Program Files\HiPic32\digital.cnf
Type	Integer	Grabber type (see FrameGrabber)	2
SubType	Integer	Acquisition module type (See AcquisitionModule)	1

[DisplayLUT]

Token	Type	Description	Example
EntrySize	Integer	Size of LUT (see LUTSize)	2
LowerValue	String	Lower value (lower cursor)	0
UpperValue	String	Lower value (upper cursor)	1024
BitRange	String	Bit range	10 bit
Color	Integer	Color (See LUTColor)	1
LUTType	Integer	LUT Type (See LUTtype)	0
Gamma	String	Gamma value	1
First812OvlCol	Integer	First overlay color in 812 bit mode (overlayed	1

		images only)	
Lut16xShift	Integer	Shift value in case of Lut16x mode	1
Lut16xOvlVal	Long	Overlay vlaue for Lut16x mode	32767

[Scaling]

Token	Type	Description	Example
ScalingXType	Integer	Scaling type in X direction (see ScalingType)	SCALING_LINEAR
ScalingYType	Integer	Scaling type in X direction (see ScalingType)	SCALING_LINEAR
ScalingXScale	String	Scaling factor in X direction	1.57
ScalingYScale	String	Scaling factor in Y direction	1.57
ScalingXUnit	String	Scaling unit in X direction	mm
ScalingYUnit	String	Scaling unit in Y direction	mm
ScalingXScalingFile	String	Scaling file in X direction	scaling1
ScalingYScalingFile	String	Scaling file in Y direction	scaling2

[Comment]

Token	Type	Description	Example
UserComment	String	Comment string inputted by the user	This is my comment

Used constants:

ApplicationType:
- APPLICATIONHIPIC = 1
- APPLICATIONTA = 2
- APPLICATIONEM = 3

CameraType:
- NOCAMERA = 0
- C4880 = 1
- C4742 = 2
- ANALOG0 = 3
- ANALOG1 = 4
- ANALOG2 = 5
- ANALOG3 = 6
- C474295 = 7
- C488080 = 8
- C474298 = 10
- C7300 = 19
- C800020 = 20
- C800010 = 21
- FlatPanel = 22
- DCam = 23

```
  OrcaHR = 24
  C8484 = 25
  C9100 = 26
  C8800 = 27

CameraSubType:
  C4880_00 = 1
  C4880_60 = 2
  C4880_80 = 3
  C4880_91 = 4
  C4880_92 = 5
  C4880_93 = 6
  C4742_95 = 7
  C4880_60OU = 8
  C4880_1K2K = 9 ' (special camera in 1k x 2K scan mode (kazuhiro hara))
  C4742_98 = 11
  C7300_10 = 12
  C4880_10 = 13
  C4880_20 = 14
  C4880_21 = 15
  C4880_30 = 16
  C4880_40 = 17
  C7190_10 = 18
  C8000_20 = 19
  C4742_95ER = 20
  C4880_31 = 21
  C4880_50 = 22
  C8000_10 = 23
  FlatPanel_C7942 = 24
  FlatPanel_C7943 = 25
  C4742_95HR = 26
  C8484_01 = 27
  FlatPanel_C7921 = 28   '6.2.0 pf1
  C4742_98ER = 29  'example: "C4742-98-24ER"
  C4742_98BT_K = 30  'example: "C4742-98-24KA"
  C4742_98BT_L = 31  'example: "C4742-98-24LA"
  C7300_10_NRK = 32
  FlatPanel_C7930DP = 33
  C9100_01 = 34
  C9100_02 = 35
  C9100_11 = 36
  C9100_12 = 37
  C8800_01 = 38
  C8800_21 = 39
AcqMode:
  LIVE = 1
  ACQUIRE = 2
  PHOTONCOUNTING = 3
  ANALOGINTEGRATION = 4
```

DatType:
  DAT8 = 1
  DAT10 = 2
  DAT12 = 3
  DAT16 = 4
  DAT812 = 5
  DAT14 = 6
  DAT16u = 7
  DAT32 = 8

FrameGrabber:
  grbNone = 0
  grbAFG = 1 'AFG board
  grbICP = 2 'ICP board with AM-DIG or AM-VS
  grbPC = 3   'PCDig or PCVision
  grbNI = 4   'National Instuments PCI 1422 or PCI 1424 or PCI 1428
  grbDCam = 5 'DCam camera

AcquisitionModule:
  AMDIG = 1
  AMVS = 2
  CamLink = 3

LUTSize:
  LUTSize8 = 1
  LutSize10 = 2
  LutSize12 = 3
  LUTSize16 = 4
  LUTSize812 = 5
  LUTSize14 = 6
  LUTSize16x = 9

LUTColor:
  LUTColorBW = 1
  LUTColorRainbow = 2
  LUTColorBWwithoutColor = 3

LUTType:
  LUTTypeLinear
  LUTTypeGamma
  LUTTypeSigmoid

ScalingType:
  SCALING_LINEAR = 1
  SCALING_TABLE = 2

Note: The scaling data is directly written to the image file if the scaling type is table. The tokens ScalingXFile and ScalingYFile contains an address where the

scaling table is written in the file. An asterik „*“ or a plus „+“ indicates the address. The asterik indicates that the scaling has 1024 entries, the plus indicates 1280 entries. If it contains e.g. the entry *473533 the scaling data is written in the image file at an offset of 473533 bytes. The format #xxxxxxxyyyy means the table with yyyy entries and address xxxxxxx.

Appendix E: Scaling File Format

Scaling files are used to provide nonlinear or special scaling (see section "Scaling Set-up" in this manual). They contain a list of of floating point numbers (4 byte type, called float or single). Each number corresponds to one pixel on the chip. The scaling file does not contain a unit nor the information for which direction the scaling is applied. Scaling files must always have the extension **.SCL**. The floating point numbers must be strictly monotonous (ascending or descending), otherwise the file is not accepted by the system as a valid scaling file. The format of the file is as follows:

```
Byte:
0,1,2,3,4,5,6,7,8,9,10,11,12...4092,4093,4094,4095
      Value0  Value1  Value2  ...    Value1023
```

Appendix F: DPC File Format

Dynamic photon counting images are saved in the DPC file format. In a DPC file the x-y coordinate of each photon and the time when it has been detected are recorded.

Bytes	Content
0-1	Characters IM
2-3	Comment length in bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File type: 2=16 Bit
14-64	Reserved
64-nnn	Comment area can contain any information. It is used by the to store the status string and the scaling tables (if any)
nnn+1-End	Data Area (Starts at address 64+ ComLen)

The **Data Area** looks like:

```
Content:
Time-Frame0   x0    y0    x1    y1   0xFFFFFFFF
Byte:
    00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16
17 18 19...

Where:
```

```
Time-Frame0:
TimeGetTime value of the frame 0 (32 bit value).
X0, y0:
x,y coordinates of photon 0 within frame 0 (two 16 bit
values)
0xFFFFFFFF:
Delimiter (32 bit value, all ones)
```

Appendix H: Cameras and Peripheral systems supported

OS: /Windows NT 4.0 SP6/Windows 98/Windows 2000/Windows ME/Windows XP

I/F: IC-PCI/PCVision/PCDIG/NI PCI1422/NI PCI 1424/DT2819/IEEE 488 (ISA and PCI)

Hardware: C4880, C4742-95, C4742-98, C6918-05, C3077, C5405, C1587, C2830, C5680, C3681, C4334, C4187, C1370, C3735, C4575, C6138, C6860, 250IS, 500IS, Acton SpectraPro, DG535, C1097-01, C4792-01, C4792-01L, C4398-01, C6878, A6538, C5987(by selecting C4880), C8800, all cameras supported by Hamamatsu DCAM drivers

Appendix I: UserFunction

The following is a printout of the prototype of the `UserFunction`

```
#include "windows.h"
short FAR PASCAL UserFunction(short iIndex, char * sStatusString, short iStringLen, char * sBack-
String, short nBackStringMaxLen, short * nBackStringLen, float ftPar1, float ftPar2, float
ftPar3, float ftPar4, short iCycleIndex);

BOOL WINAPI DllMain( HANDLE hModule, ULONG ul_reason_for_call, LPVOID lpReserved)
{
        switch(ul_reason_for_call)
        {
                case DLL_PROCESS_ATTACH:
                        return(TRUE);
                        break;
                case DLL_THREAD_ATTACH:
                        return(TRUE);
                case DLL_THREAD_DETACH:
                        return(TRUE);
                case DLL_PROCESS_DETACH:
                        return(TRUE);
        }
        return 1;
}

short FAR PASCAL UserFunction(short iIndex, char * sStatusString, short iStringLen, char * sBack-
String, short nBackStringMaxLen, short * nBackStringLen, float ftPar1, float ftPar2, float
ftPar3, float ftPar4, short iCycleIndex)
{
        short iLen;

        iLen=0;

        switch (iIndex)
        {
                case 0: /* Called from the Function panel */
                {
                        break;
```

```
}
case 1: /* Start of C4880 LIVE mode */
{
       break;
}
case 2: /* Start of C4880 ACQUIRE mode */
{
       break;
}
case 3: /* Start of C4880 ANALOG INTEGRATION mode */
{
       break;
}
case 4: /* Start of C4880 PHOTON COUNTING mode */
{
       break;
}
case 5: /* Start of C4880 BackSub LIVE mode */    Note:obsolete
{
       break;
}
case 6: /* Start of C4742 LIVE mode */
{
       break;
}
case 7: /* Start of C4742 acquisition (except Live mode) */
{
       break;
}
case 8: /* Start of analog camera LIVE and Acquire mode */
{
       break;
}
case 9: /* Start of analog camera ANALOG INTEGRATION mode */
{
       break;
}
case 10: /* Start of analog camera PHOTON COUNTING mode */
{
       break;
}
case 11: /* Start of analog camera Sync LIVE mode */
{
       break;
}
case 12: /* Start of analog camera Single Exposure Sync LIVE mode */
{
       break;
}
case 13: /* Background subtraction for C4880 */
{
       break;
}
case 14: /* Background subtraction for C4742 */
{
       break;
}
case 15: /* Background subtraction for analog cameras */
{
       break;
}
case 16: /* Start background subtraction from file */
{
       break;
}
case 17: /* End background subtraction from file */
{
       break;
}
case 18: /* End Acquisition for C4880 (all modes) */
                /* The return string is pasted to the comment of the image! */
{
       break;
}
case 19: /* End Acquisition for C4742 and analog cameras (all modes) */
            /* The return string is pasted to the comment of the image! */
{
       break;
}
case 20: /* Start shading correction */
{
```

```
                break;
        }
        case 21: /* End shading correction */
        {
                break;
        }
        case 22: /* Start curvature correction */
        {
                break;
        }
        case 23: /* End curvature correction */
        {
                break;
        }
        case 24: /* Start cycle loop */
                        /* iCycleIndex only valid with 24, 25 and 26 */
        {
                MessageBox (NULL, "Start of Cycle", "Cycle", 0);
                break;
        }
        case 25: /* End acquisition within cycle loop */
                        /* The return string is pasted to the comment of the image! */
                        /* iCycleIndex only valid with 24, 25 and 26 */
                        strcpy (sBackString,"User Function index 25 executed");
                        iLen=strlen(sBackString);
        {
                break;
        }
        case 26: /* End cycle loop */
                        /* iCycleIndex only valid with 24, 25 and 26 */
        {
                MessageBox (NULL, "End of Cycle", "Cycle", 0);
                break;
        }
        case 27: /* Start of a sequence */
        {
                break;
        }
        case 28: /* A single acquisiton during sequence mode has ended */
                        /* If the return string is "stop" the sequence ends! */
        {
                /* This ends the sequence:      */
                /* strcpy (sBackString,"stop"); */
                /* iLen=strlen(sBackString);    */
                break;
        case 29: /* After each new image in Live mode*/

        }
        default:
        {
                strcpy (sBackString,"No valid index number specified");
                iLen=strlen(sBackString);
                break;
        }

}

        * nBackStringLen=iLen;
 return 1;

}
}
```

User function in Sequence mode

Depending on the submode used for sequence acquisition differnt cycles are executed (please refer also to "Details of sequence mode" in the chapter "Sequence":

Mode S (fastest mode)

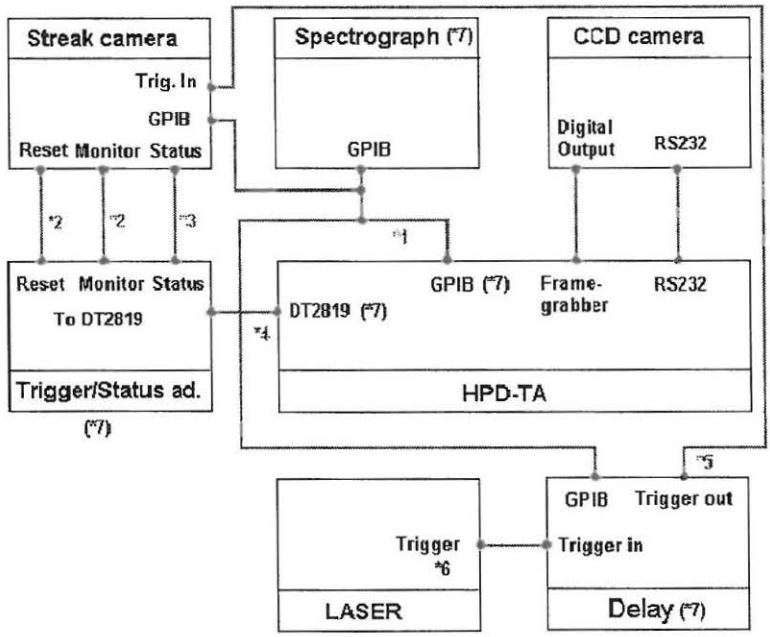
```
UserFunction 1 (Live mode) or 2 (Acquire mode)
UserFunction 27
Do
        Single acquisition
        UserFunction 28
Loop for all images
UserFunction 18 (C4880) or 19 (all other cameras)
```

Mode F (most flexible mode)

```
UserFunction 27
Do
        UserFunction 24
        GetImage (within this function the user function is additionally called as if the normal
                corresponding acquisition mode is called)
        UserFunction 25
Loop for all images
UserFunction 26
```

Appendix K: Typical hardware configurations

Standard configuration of a streak system with digital camera readout



Cabling of streak camera system with digital cameras (C4880, C4842-98 or C4742-95)

*1:Optional, only when either streak camera, delay box or spectrograph can or should be controlled by GPIB (Normally these devices can also be operated manually).

*2:Optional, only necessary for single shot streak camera (if it is operated in single mode).

*2a:Monitor signal should be connected for DT2818/CTR05 or CCD camera depending on Trigger method (see also"Trigger Setup")

*3:Optional, only available when the streak camera is equipped with a status port. The function of getting status information is also fulfilled when the streak camera is controlled by GPIB.

*4:Optional, only when trigger handshake cables or status port of the streak camera is used.

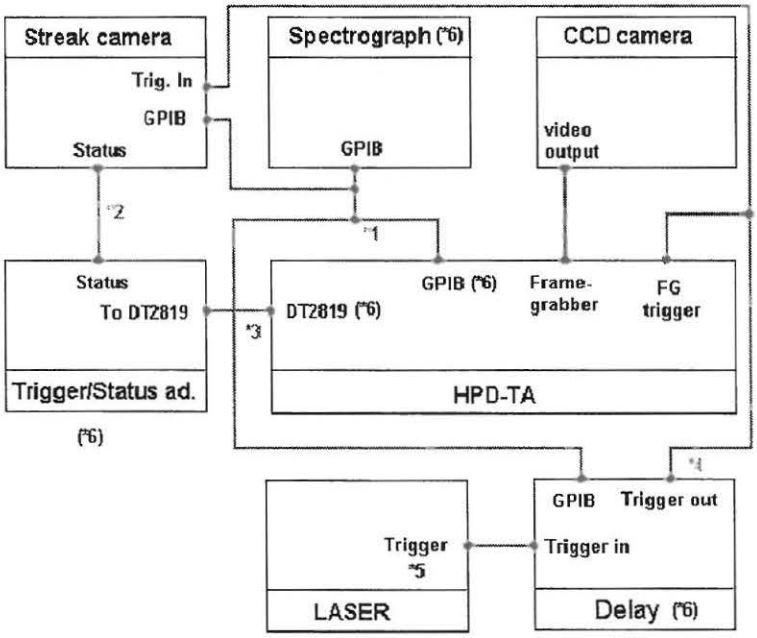
*5:Optional. If no delay box is used this cable should be connected directly to the trigger output of the LASER.

*6:This trigger output can have various sources depending on the LASER setup:
- An electrical trigger output from the LASER

– A PIN diode used for trigger output.
– An electrical output from a trigger generator used to trigger the LASER.

*7:Optional equipment.

Standard configuration of a streak system with analog readout camera



Cabling of streak camera system with video output.

*1:Optional, only when either streak camera, delay box or spectrograph can or should be controlled by GPIB (Normally these devices can also be operated manually).

*2:Optional, only available when the streak camera is equipped with a status port. The function of getting status information is also fulfilled when the streak camera is controlled by GPIB.

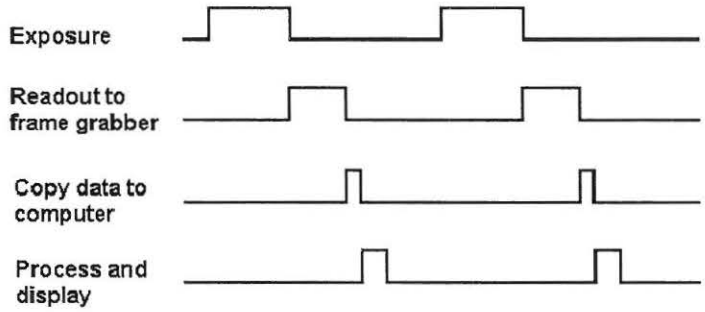
*3:Optional, only when trigger handshake cables or status port of the streak camera is used.

*4:Optional. If no delay box is used this cable should be connected directly to the trigger output of the LASER.

*5:This trigger output can have various sources depending on the LASER setup:
- An electrical trigger output from the LASER
– A PIN diode used for trigger output.
– An electrical output from a trigger generator used to trigger the LASER.

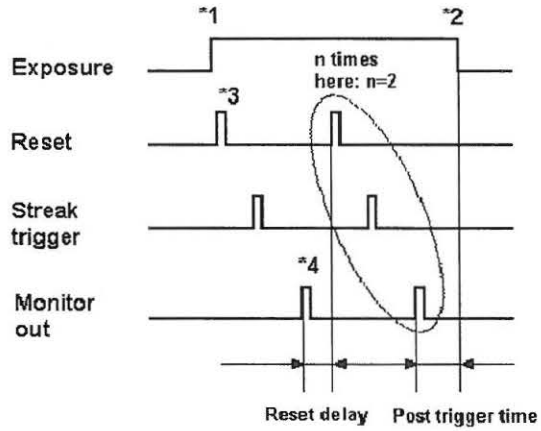
*6:Optional equipment.

Typical timing diagram of a streak system without triggering



Acquisition timing with internal camera timing mode (any camera, without any trigger).

Timing diagram with trigger handshake and digital camera readout (Enclosing method)



Acquisition timing with streak trigger handshake (digital cameras only)

1*+2*: The exposure is started and stopped by the HPD-TA under software control.

1*: For C4880 this is done by sending a ACQ command via RS232, for the C4742-95 camera this is done by setting the external trigger line to active (the camera is switched to external trigger mode, level trigger and trigger source to digital I/F by the program).

2*: For C4880 this done by sending a STP command via RS232, for the C4742-95 camera this is done by setting the external trigger line to inactive.

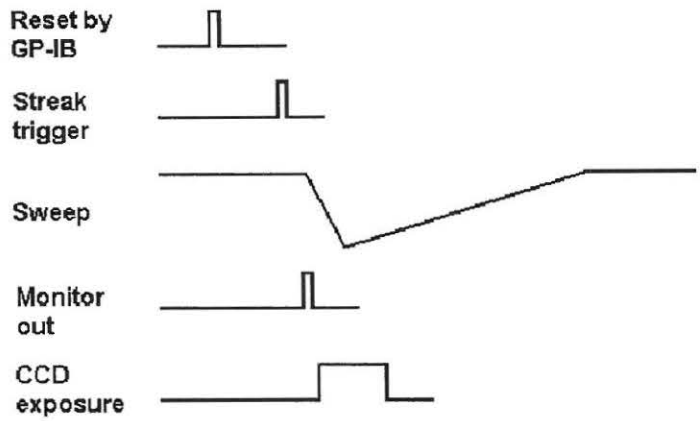
3*: Sending reset can be done by the DT2819 reset line or by GP-IB command depending on the installed hardware.

4*: The monitor out signal is detected by the DT2819 or by GP-IB command depending on the installed hardware.

Note:

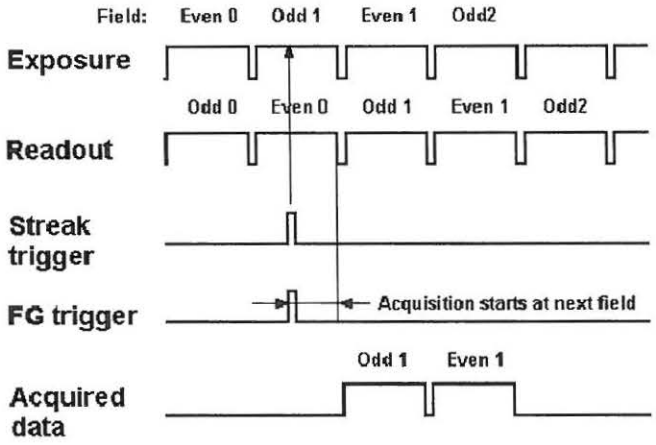
1: N sweeps can be integrated by counting n triggers within one exposure.

Timing diagram with trigger handshake and digital camera readout (Sequential method)



Acquisition timing with streak trigger, Sequential method (digital cameras only)

Timing diagram with trigger handshake and analog camera readout



Acquisition timing with FG Trigger (frame grabber trigger, video camera only)

Notes:
The acquisition always starts at the next field.
If the streak trigger appears at the vertical blank, the CCD camera may not register the light (depending on the CCD camera).
There is no streak trigger handshake (no reset pulses are sent) available, so the streak camera must be operated in continuous mode.
The streak sweep and the FG trigger pulse should have the same timing.
If the sweep is very long a series of neighboring frames can be averaged (up to 8 depending on the memory size of the IC-PCI main board).
Only one trigger can be detected for one frame. If the frequency is higher than the video frame rate this triggering does not make sense. Use acquisition without FG trigger instead.

Glossary

Acquire Mode

A scanning mode of C4880 type cameras. In the C4880 terminology it is called "Slow Scan Mode". This mode allows to acquire single images with the highest possible quality.

Analog Contrast Enhancement

C4880 cameras and C4742 cameras have an analog contrast enhancement circuit built in. It allows to increase the analog amplifier gain (before the signal is digitized) and to subtract a analog offset signal. In case of C4880 cameras the enhancement function works in Live Mode only.
This function can be used to spread the contrast of an image within a desired intensity range.

Analog Video Camera

In this manual standard video cameras, which offer an analog video output signal according to RS 170 or CCIR (System B) standard are called "Analog video cameras". Hamamatsu offers for example the types C3077 (2/3"), C5405 (½") and C 5403 (1/3").

Background Subtraction

Subtraction of a background image from an acquired image. The background image is typically a image acquired under complete darkness. This image contains the camera readout noise, dark current and offset signals. Sometimes this function is called "Dark subtraction" or "Dark current subtraction".

Binning Mode

A special readout mode of C4880 and C4742 cameras. Already in the camera the charges from a predefined number of pixel is accumulated. The accumulated charge signal is then digitized and read out. Binning allows to get a higher camera sensitivity and reduce the amount of data. Of course this function works in expense of spatial resolution.

Current image

The image window which is the active window, or which was the last active image window before another (non-image) window was opened.

DCAM, DCAM driver

DCAM driver are unified software drivers supplied for most of the cameras. The Hamamatsu DCAM driver concept allows to change easily between different camera and interface versions.

DDE

Dynamic data exchange. This function allows to send measurement data automatically to another program (like Excel), where they can be further processed. DDE is supported for export of profile and 3-D analysis data.

Fast Scan Mode

Same as Live mode.

High Precision Scan Mode

Same as Acquire mode.

IC-PCI

Frame grabber board with PCI bus. Different versions are available: 2M/DIG with 2 MByte frame memory for digital input signals, 2M/VS with 2MByte frame memory for analog video signals and 4M/DIG with 4 MByte frame memory for digital input signals.

Interlaced

A way of image data readout from standard analog video cameras. One image (frame) is read out as two fields.

Live Mode

A mode to acquire and display images continuously. This mode is available for all cameras. In case of C4880 type cameras, the camera is switched to the fast readout mode.

LUT (Look up table)

A conversion table which is internally calculated to convert intensity values. It can be used to convert black and white images into pseudocolor images or to make contrast enhancement.

Menu Bar

Main application control window. From this window you can control all submenus and commands.

Photon Counting

A special image processing mode which can be used in combination of image intensifier or streak cameras with C4880, C4742 or Analog video cameras. If the gain of the intensifier is high, single photon events can be detected by the camera as a relatively bright spot. The photon counting function can process these images and record each spot a single photon event. This mode allows to accumulate low light level images with best signal to noise ratio and highest sensitivity.

Realtime background subtraction

A background image is continuously subtracted from images acquired in Live mode. This function is usefull to subtract mottle images or dark current images.

ROI

A Region Of Interest (ROI) is a part of the image which was selected by the user using the ROI definition tools

Scaling

If physical dimensions are assigned to images or profiles, we call it scaling (for example µm or m, wavelength etc.). The scales may be of linear or non-linear type.

Scanning mode

The C4880 allows to work with two different scanning modes. Fast scanning mode is mainly applicable for image adjustment (focusing), while the high precision mode is used for precise image acquisition. In HiPic the fast scanning mode is called "Live mode" and high precision mode is called "Acquire mode"

Sequence

The Sequence function allows to automatically record large numbers of image and/or profile data, stored either in RAM or on hard disk.

Shading Correction

A uneven image brightness is called shading. It can be corrected by multiplying each pixel of an image by a correction factor. Typically the correction factors are obtained from an reference image.

Subarray Readout Mode

A readout mode of C4880 cameras. Only a user-predefined area of the CCD is read out. This function can be used to reduce the amount of data and speed up the readout, if only a part of the image is necessary for analysis.

Superimpose

A image processing function to overlay two images.

Super Pixel Mode

A special binning mode where a square number of pixel is binned (e.g. 2 x 2, 4 x 4). This function can be used to increase camera sensitivity, increase the readout rate (frame rate) and reduce the amount of data.

TIFF

Image file format. TIFF is widely used as image format. Most application programs can import TIFF files.

User Functions

In order to extend the functionality of the program to users needs, it is possible to call user-programmed DLL functions from many locations within the program, especially within the acquisition procedures. These function calls are called user function calls.

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